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FLOWERING PLANTS,

AS ILLUSTRATED BY BRITISH WILD-FLOWERS.

By R. Lloyd Praeger, B.A.

V.—DISPERSAL AND DISTRIBUTION.

To resume the consideration of the means employed by plants to ensure a wide dispersal of their seeds. We have seen how much the available motive agents—wind, water, animals—are taken advantage of. There is, in addition, a large number of plants which do not rely on any external agency to carry their seed, but do the scattering themselves, by one or another ingenious device. If we lie on a sunny bank among the Gorse in August, we shall hear a sharp snapping noise coming from the prickly bushes at frequent intervals. This is due to the sudden rupturing of the ripe pods, owing to unequal shrinkage caused by their drying. The walls of the fruit are composed of layers of cells which vary in the amount to which drying causes them to contract. When the stress due to the irregular contraction thus produced reaches a certain point, the walls give way, and each half of the pod jerks into a spiral form, projecting the enclosed seeds to a considerable distance.

Examine a fruit of the common Dog Violet. It is a little capsule formed of three sections. As it ripens it opens along the lines of junction of these, and we get three narrow boat-shaped valves spreading horizontally from the fruit-stem, and each containing several seeds. The drying of these valves causes contraction. The two gunwales, so to speak, of each boat are drawn together, pressing more and more tightly on the seeds which lie between, till one by one the seeds spring out with considerable force.

In other cases a similar violent expulsion of the seeds is caused by unequal growth in the tissues of the seed-vessel. This it is that produces such a state of stress in the five-parted capsules of the Touch-me-not that when ripe a puff of wind or a light touch causes a violent explosion of the fruit, by which the seeds are scattered far and wide. A more familiar example may be studied in the little Hairy Cress, so common a weed in gardens. While weeding a bed early last June, in which there was a quantity of this plant, which had unwisely been allowed to exceed the period of flowering, the bursting of the little narrow pods and the flinging of hundreds of seeds in my face amounted to a positive nuisance, and caused reflections concerning the wisdom of an old saying about a stitch in time.

Some of the Crane's-bills fling their seeds to a considerable distance by means of a more complicated apparatus. The fruit consists of five separate carpels attached by their apices to a spindle. Each carpel consists of an egg-shaped pouch containing one seed, pro-

Fig. 1.—The Bloody Crane's-bill, showing sling-fruit. ½ nat. size.

longed into a slender rod, the whole adpressed to the spindle, so that the five pouches lie in a ring round its base. Each pouch is open on the side which is pressed against the spindle. As the fruit ripens, the more rapid shrinking of the outer layers of the rod of the carpel causes it to rupture the tissue which attaches it by its whole length to the spindle, and it curls with a jerk, carrying up the pouch, and causing the seed to fly out

of the opening on its inner side already referred to. Lord Avebury placed fruits of the Herb Robert on his billiard-table, and found that the seeds were in this manner projected to a distance of over twenty feet. Fruits of this kind have been aptly named sling-fruits. Nor is it beyond the powers of certain species to undertake even the *planting* of their seeds. The Stork's-bills (*Erodium*), which are closely allied to the Crane's-bills or Geraniums, have curious fruits, each consisting of a torpedo-shaped seed prolonged into a slender twisted rod, which terminates in a long appendage set at right angles to the axis of the remainder of the fruit. The seed is furnished with bristles pointing away from the unattached end; and the twisted tail is hygroscopic—very sensitive to moisture. Now, if the seed be held fast, and the whole moistened, the rod will untwist, and as a result the free end will revolve like the hand of a clock. But if, as will more likely happen in nature, this revolution causes the long appendage to come in contact with some obstacle—a blade of grass, for instance—then the motion will be transferred to the seed-bearing end, which will revolve like an auger, and, as a result of the lengthening caused by the untwisting of the rod, the seed will be forced into the ground. The upward pointing bristles will come into play if the rod dries again, tending to hold the seed down in its place in spite of the contraction, and to drag down the opposite end instead; another moistening will cause the seed to burrow deeper. A much simpler, but very pretty instance may be watched in the little Ivy-leaved Toad-flax, a plant of the European continent which has now spread over the greater part of the British Islands. It grows on walls, and when in flower the pretty purple Snapdragon-like flowers stretch out towards the light and air. But as the fruit ripens its stem bends towards the wall, and seeks the deepest cranny it can find, in which the seed may be deposited. Owing to this arrangement, the fruit needs no winged appendage or other device such as is possessed by so many wall plants, to prevent the seed from falling uselessly to the inhospitable ground below.

Fig. 2.—A Fruit of the Musky Stork's-bill. × 2.

Thus far regarding the dispersal of plants by means of their seeds. We have not yet nearly reached the limit of power of spreading which our wild flowers possess, for vegetative reproduction plays a most important part in this chapter of their life-history. We may, if we wish, separate the latter processes into two groups, according as to whether the new shoot separates from the parent plant, or remains, for some time at least, attached to it. In all cases it is of great importance to note that reproduction of this kind is not due to the *offspring* of the plant, but to a portion of the parent itself, which sooner or later commences an independent existence; it is due to a prolongation of the life of a single generation, not the production of a new generation. In some instances it is the new shoot alone which survives from one season to the next. If we examine in autumn a plant of one of the Bladderworts, pretty floating plants with limp straggling stems and no roots, the stem will be found to terminate in a rough egg-shaped knob. If we examine a plant in early spring, the stem is seen to arise from a similar knob. A rootless floating plant like this would get killed during the winter by being frozen into the ice, so it concentrates its vitality in these knobs—in reality, much compressed stems—which sink to the bottom, while the rest of the plant decays, and lie snugly there till spring, when they rise again and send out fresh elongated stems, with leaves and flowers. Similar winter buds, or *hibernacula*, may be seen on the Frog-bit, certain Pond-weeds, and other aquatic plants. In these cases the buds are terminal, and represent the contracted stem, which really grows on year by year, being elongated in summer, contracted in winter.

Bulbils are found on a variety of plants. They are little adventitious buds borne on the stems or leaves, or in lieu of flowers, which sometimes remain attached to the parent, sometimes drop off to commence at once a separate existence. In the proliferous section of the protean varieties of the Soft Shield Fern (*Polystichum angulare*), for instance, they may be seen crowded along the rachis or midrib of the frond, and in a damp atmosphere form a verdant row of little ferns before the decay of the frond allows them to reach the ground and take root. In the Lesser Celendine, again, little egg-like bulbils are borne in the axils of the leaves; they drop off and immediately commence life on their own account. Many of the species of Leek and Onion (*Allium*) are conspicuously bulbiferous, the umbel of flowers being crowded with little bulb-like buds which sometimes altogether replace the blossoms.

In the majority of instances the increase of plants by vegetative reproduction is accomplished by means of the continued growth of their stems, some or all of which, instead of rising erect, creep on or below the surface of the ground, giving off, continuously or at intervals, roots below, leaves and flowers above, and capable of quite indefinite extension—see the first article of this series (*supra*, p. 27). The common Polypody grows on and on year by year in this manner, the hinder end of the stem dying by degrees. The Butterbur, whose great leaves form such picturesque masses of foliage on our river banks, grows similarly, with a stem which pushes its way below the surface. Instances where roots and shoots are produced only at intervals are equally common—the Strawberry and Sitfast are familiar examples. Underground stems of the same kind are abundant. These it is that are so useful in binding together shifting sands—stems like those of the Bent, Lyme-grass, Sea-sedge. The growth of the last-named (*Carex arenaria*) is most interesting. On bare sandy patches one may note the tufts of leaves and flowers rising at regular intervals in a straight line for several yards. Digging a few inches downwards, we discover the connecting stem, running straight and level underground, and terminating in a long point, white, polished, and hard as ivory, which pushes its way ever forwards through the sand.

Bramble-stems often form a high arch in the earlier part of their yearly growth; but in the autumn they curve earthwards, and the growing point enters the soil, where it roots and turns sharply upwards again. Next year the arched stem flowers and dies, but a new plant starts from the rooted tip; and so the bramble goes looping along year by year. A few years ago I noted a bramble-bush with rooted shoots averaging over 20 feet in length; a calculation will show that in six years, at the same rate of growth, a single bush might cover an acre of ground.

The well-known "fairy rings" of pastures are produced by the continuous growth of the *mycelia*, or webby underground stems, of certain fungi. These, starting from one point, and spreading regularly, exhaust the soil in which they live, so that as their area of growth

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expands, the central portion keeps dying off, and a slowly enlarging ring of growing fungus results. The visible effect produced is due to the fact that the plant acts injuriously on the surrounding vegetation, producing a withered ring where the fungus is growing. But inside of this is a ring where both the fungus and its victims have died, and on the soil thus left untenanted, and enriched by the dead vegetable matter, a luxuriant vegetation has sprung up, which catches the eye. Rings formed in a similar manner, by steady outward growth and the dying off of the older central portions, may be not unfrequently observed among the higher plants.

Roots also lend themselves sometimes to vegetative reproduction, producing leafy shoots, which become independent plants. The White Poplar is often surrounded by progeny of this kind, and the Sea-Buckthorn covers large areas of sand-dunes by the same means. Tubers, such as those of the potato, are also really stem-structures produced by the roots.

Having thus briefly reviewed the various modes in which seed is dispersed and scattered, and also those by which vegetative reproduction is carried on, we are now in a position to study the distribution in any given area of the various species which compose its vegetation, so far as this is the result of its methods of reproduction. In the case of plants which produce flying fruit, we should expect to find the individuals very widely spread, and generally growing singly, in open situations such as these species affect, where in turn their flying fruit may be freely exposed to the wind which will bear it away. Plants of which the fruit is eaten by birds should likewise have a wide distribution, and we might perhaps especially expect these about bushes and hedges, wherein birds would perch or shelter. Where no devices exist for a wide dispersal of seed, we might look for a more social grouping of individuals, in little colonies, or dotted over larger areas. And in the case of plants which can increase by means of their creeping stems, we might often expect to find dense growths, and if I may use the expression, populous cities. At the same time it must be remembered that all sorts of other conditions and requirements exist simultaneously to modify or obscure such groupings; but the general application of these rules will at once be observed by the field-botanist. Our common thistles, for example, have flying fruits; furthermore, their formidable armour of spines renders them invulnerable to grazing animals; hence we find them scattered far and wide over the pastures. The Field Thistle has far-creeping underground stems; hence it forms dense patches, almost impossible to eradicate, while the Spear Thistle and Marsh Thistle, destitute of creeping stems, rise singly. The Wood Anemone, growing in shady places, could not use flying seeds to advantage; the seeds are devoid of means of wide dispersal, and the stems creep; both causes combine to make the plant grow in the lovely dense sheets of tender green dotted with white flowers that we know so well. Its ally, the Pasque-flower, on the contrary, lives on the open downs. The stems do not creep, the fruit is formed for wind-carriage; in consequence we find the plant dotted here and there over wide areas. Most of our wild flowers which have bulbous "roots" produce young bulbs as offshoots of the parent ones, thus tending to establish dense colonies—note the profusion in which the Wild Garlic (Fig. 3) and the Wild Hyacinth grow. Many of our marsh and water plants have creeping stems, which tend to produce striking masses of vegetation—witness the miniature forests of the Reed, Bulrush, Reed-mace, or Sedge which fringe the ponds and lakes, often so dense that no other plant can obtain a footing among them. Certain common land plants with creeping stems and large leaves, such as the two more familiar species of *Petasites*—the common Butterbur and the Winter Heliotrope (Fig. 3)—form such dense masses of foliage as to effectually choke off and kill all other plants on the area which they invade. On the hill-sides, two of our most strongly social species—the Heather and the Bracken—often come into sharp contest, each holding undisputed sway over certain areas, with a border-line where no doubt a keen struggle is continually going on—the Bracken having the advantage of creeping branching rhizomes or underground stems, and tall dense growth which overshadows its rival; the Heather on its side being possessed of great vitality and fertility, and perhaps other less evident advantages, which enable it to hold its own.

Fig. 3.—A Study in Gregarious Plants—Winter Heliotrope, Ramsons, and Ivy.

But as we have said, many other factors are at work influencing the distribution of plant life—questions of soil and of situation; of water supply, and the supply of air and light; and there is the keen struggle for existence between plants of similar proclivities, and a complicated and incessant action and reaction not only

between plant and plant, but between plant and animal —between the plant, indeed, and its whole environment. We thus find, in any selected area, a group of plants, often differing widely in size and appearance, in mode of growth and mode of dispersal, which nevertheless forms a strictly natural group, living together by reason of their being adapted to the particular conditions of life which prevail. To such natural groups of the vegetation the name of *plant associations* has been given. Such an association is often dominated by one or more social species, which, growing in great numbers, control more or less the entire association. In other cases, though some plants may be more abundant than others, the association may be a commonwealth rather than a monarchy. Let us glance at a few instances. On the sandy sea-shore, vegetation is limited, but between the reach of the waves on the one side, and the bent-covered dunes on the other, a certain number of plants maintain an existence. The Sea-Holly is here, with its leathery spiny foliage; the bushy succulent leafless prickly Salt-wort; straggling plants of Orache; the beautiful Horned Poppy, with its grey downy foliage and splendid yellow blossoms; the Sea-Rocket, also of bushy growth, with tough stems and succulent shiny leaves; and the Sea-Spurge, which matches the Sea Holly and Horned Poppy in the grey tones of its foliage. What conditions have determined the selection of this group of plants? In winter the sea washes right over these sands, and even in summer the air is full of salt. Very few plants could endure the salinity which pervades the place; but these particular species not only endure it, but cannot exist without it; we find them nowhere but on the edge of the sea. Next, the exposure here is very great. The wind whistles along these bare sands, carrying spray, or driving sand. The plants are all low, tough, bushy, strong-rooted, suitable for withstanding gales. Heat and drought are much felt here, and would prove fatal to many species; but all these have roots which strike deep into the sand; some, like the Salt-wort and Sea Rocket, store up a large reserve supply of water and food in their fleshy leaves; others like the Sea Holly, in their long juicy underground stems; and all provide against too great transpiration, by means of a thick impermeable skin, or a felt-like covering of hairs; often accompanied by a reduction in the number of stomata—the pore-like openings of the leaves. Competition can play but little part in the economy of this plant association; there is room for plenty more; the abundant space allows each plant to spread out, low and bushy. Human interference is also at a minimum here, and animal depredations likewise—though we note that the Sea Holly and Salt-wort both provide for this contingency in the production of a formidable array of thorns. The dominant conditions are undoubtedly the saltness and the exposure; these are the features of the environment that have chiefly determined the limits and character of the plant association.

Let us take an example of quite another kind—a wood of Beech. Here the tall trees form the leading feature, and dominate the whole association. The deep shade cast by the foliage precludes a large number of plants from trespassing here or enjoying the thick layer of leaf-mould which has formed; the few that have crept in are spindly and sickly from their vain efforts to obtain a sufficiency of light. But even the denser portions of the wood are inhabited by a variety of herbs, and on examination, we find we may group these under two heads: (1) spring flowers, such as Primroses, Wild Hyacinths, Wood Sanicle, which by growth early in the season produce their leaves and blossoms before the foliage overhead has yet screened out the sun and rain; and (2) saprophytic plants, such as the Bird's-nest Orchis, which, instead of attempting to manufacture plant-food by means of green leaves and sunlight, derive their plant-food ready-made from the decaying vegetable matter, and thus are enabled to flourish in the gloomiest recesses of the forest. In this case the Beech forms a strongly dominant species; the subsidiary vegetation being influenced chiefly by the limitation in the supply of light. It is to be noted that the conditions which exclude so many plants are advantageous or necessary for the members of the association. Were the trees cut down, the saprophytes would disappear at once, and most of the other plants would seek a more sheltered habitat.

Consider next the conditions prevailing in a pasture. Here intense competition is going on; every scrap of the surface is densely covered with vegetation; and in addition, grazing animals are perpetually nibbling the herbage, destroying the leaves and flowers. Note the upright growth of all the plants composing the association, and the narrow leaves which most of them have assumed, to get up into the light and air as far as possible with the least expenditure of material. Several species of grasses are here dominant species; some *Compositæ*, such as Daisies, Hawk-bits, and Cat's-ears, also appear well able to hold their own. There is also an interesting group of semi-parasitic *Scrophulariaceæ*—the Eyebright, Yellow-rattle, and Red-rattle, which, when they get a chance, help themselves and hinder their neighbours by fastening on the roots of the latter and drawing therefrom plant food ready-made. Most of the species are perennials, almost the only annuals being the group last mentioned, which are certainly advantageously circumstanced. The plants comprising such an association must be very hardy species, able to hold their own in a keen struggle for room, and to produce fresh leaves and perfect their flowers and fruit in spite of the depredations of the sheep and cattle.

Or to take, finally, the vegetation in the centre of a great turf-bog. Here, again, we revert to conditions entirely uninfluenced by man or by grazing animals. We have again a strongly dominant species—the Ling. Competing with it for dominion we may have one of several others—the Bog Asphodel, or one of the sedges. The supremacy varies according to the degree of moisture. On the drier portions, the Ling easily holds its own; but where the peat is wetter, the Bell-Heather is a dangerous rival; and where water usually lies, the Beak-rush holds sway. Compared with the flora of the pasture, the variety of plant-life is very limited—perhaps not more than a dozen species in as many square yards; very few plants can tolerate the peculiar conditions which prevail—the intensely peaty soil, the soaking spongy ground, and the competition of the overmastering Ling.

THE WHITE NILE—FROM KHARTOUM TO KAWA.

AN ORNITHOLOGIST'S EXPERIENCES IN THE SOUDAN.

By Harry F. Witherby, f.z.s., m.b.o.u.

IV.—CAMPING AND COLLECTING.

Whilst travelling up the river we had noted different places where the country seemed most suitable for birds, and for making collections. Arriving at such a spot on our return journey, if satisfied with our former choice, we selected the shadiest tree available under which to pitch

the tents, and setting our "trusty" followers to work, we soon had a camp neatly arranged and in working order. While one of us remained in camp, the other two sallied forth to the hunt.

Most of our work was done between five and eleven in the morning. From eleven to three we rested in the shade, and from three until sunset we were collecting again. But the morning hours were generally the most profitable, the afternoon being hotter and often spoilt by a sandstorm, while in the evening a necessary slaughter of pigeons for the pot usually had to be undertaken. When out collecting each of us was accompanied by a man to carry the birds, and perhaps a spare gun and a water bottle. When five or six birds had been shot the man was sent back to camp with them so that no time should be lost in the skinning, and as decomposition often set in within two or three hours after death, we found this plan necessary as well as convenient. For carrying the birds we employed a stick, to which were tied at intervals pieces of thread, a space being left in the middle of the stick for the hand. To one end of each piece of thread was tied a small bit of cork and to the other a pin. When a bird was shot the pin was pushed through its nostrils and into the cork. The bird thus hung free from the stick and its plumage was in no danger of being rubbed and injured. Only one of our men showed any liking to come out shooting. They were not sportsmen. Innumerable excuses were invented when they were told to accompany us. But excuses were vain—answers could also be invented. Was illness pleaded—pills were administered, a species called the "Livingstone rouser" being most effective, but the man must come. Did a man say that he had lost his shoes and could not walk through the thorns, then he must take another's shoes and be quick. We had no mercy, nor had the companions of the malingerer. They laughed like children when an excuse was silenced.

As is always the case, or at all events wherever I have collected, certain birds, and generally the common ones, interfere with the collecting of others. We were much annoyed by a species of babbler* of about the size of a blackbird, and of a light brown colour, but with a white head, which was lucky for us, as it made them conspicuous and so easier to avoid. They were common where the trees and bushes grew thick, and were always in small companies. When we were unfortunate enough to come suddenly upon one of these companies the babblers seemed to go mad—whether with rage or terror I never could determine, and assailed us with an incessant stream of the hoarsest alarm-notes. This noise, for it can be called nothing else, was made up of a number of "churrs" so rapidly repeated that the whole sounded like a policeman's rattle turned with feverish anxiety. Moreover, the birds performed in company, sitting side by side on a bough and often touching one another. Were you so unwise as to try and drive them away they only retired to another bush and redoubled the noise. If you tried to creep away they followed you advertising your presence to every other bird, and it was a long time before you could finally shake them off. Then there were four kinds of pigeons that were numerous and would rush out of a tree which you were carefully approaching, with such a flap that all the other birds took alarm, and a thick tree often contained twenty birds or more. In another way we were handicapped by two little birds, the pallid warbler† and the lesser whitethroat.‡ The majority of the birds in every thick tree or bush were sure to be either pallid warblers or whitethroats. The difficulty was to discover what else the bush contained. Many of the bushes were so thick that it was not until the birds came near the edges that they could be seen. A thorough examination might occupy a quarter of an hour and then perhaps no other birds but these two would be found. A good pair of binoculars is in every way the ornithologist's best friend, and although a glass should not be relied upon to too great an extent in identifying birds, it was of the utmost service in this work. I was the happy possessor of a pair of Goerz's Trieder binoculars. Everyone praises his own glass, but of all those I have tried none has been so good as this glass for my purpose. The power which magnifies nine diameters can be focussed and used perfectly easily with one hand, which is a great advantage, the definition is excellent, and although the "field" is not large, the glass is so light that it can be moved about quickly and with a little practice even a flying bird can be "picked up" immediately.

In this country of dense bushes and tame birds a knowledge of the notes of the birds was most valuable and a great saving in time. By a systematic identification of the performers all the commoner notes were quickly learnt, and then an unknown or doubtful sound proceeding from a thick bush at once drew attention. By means of these notes many of the rarer and smaller birds we obtained were first detected. For instance, one day I had got to the fringe of the wooded tract of country and had reached the beginning of the desert when I heard the sweetest possible little note proceeding from a thorn bush. The bush, although quite leafless, was so thick with green shoots that I could see no bird in it, but the note was so soft and delicate that I knew it must have been uttered by a tiny bird. I went some paces away and waited. After a time four or five most elegant little bush warblers§ appeared on the outside of the bush. Most refined little birds they were with most charming actions. They moved quickly and gracefully from twig to twig, and often fluttered to the ground in their search for insects, and except when actually flying they were incessantly flirting their long tails from side to side with a quick, jerky but dainty motion. We afterwards found these little birds in the acacia trees bordering the desert, and heard their warbling song, which was so soft that a near hearing and perfect silence were necessary for it to be fully appreciated.

In some cases, however, neither our glasses nor our ears were of any service in determining the species of a bird. Two birds which we obtained I thought at the time were reed warblers,‖ but on a comparison at home one of them proved to be a marsh warbler.¶ Both these species come to England in the summer, and here in their breeding haunts their different nests and songs and habits make them perfectly distinct. But the birds we obtained were migrating from their winter abodes, perhaps much further south. The habits appeared to be exactly similar, they were not in song, nor did we hear them utter even a call note, so that there was nothing to differentiate them except their size or plumage. But in size they are exactly the same, while even with the two birds side by side in the hand their plumage is so

* *Crateropus leucocephalus* (Cretzschm).

† *Hypolais pallida* (Hempr. et Ehr.). ‡ *Sylvia curruca* (Linn.).
§ *Spiloptila clamans* (Temm.). ‖ *Acrocephalus streperus* (Vieill.).
¶ *Acrocephalus palustris* (Bechst.).

similar that no one but an expert would detect the difference.

It was most interesting to come across birds with which one was familiar in England in their winter resorts or on their migrations so far to the south. The extraordinary power of the migrating impulse was

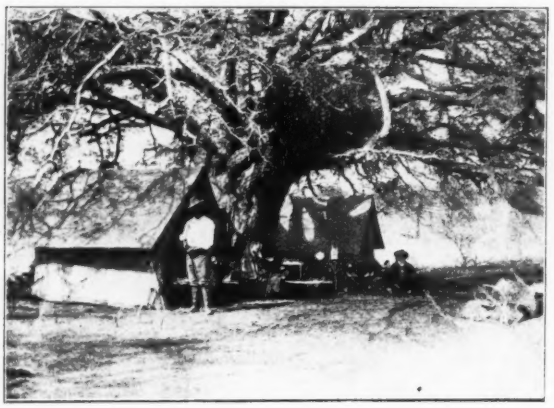

Fig. 1.—Camp at Duem.

brought vividly home to me by the presence of a solitary red-throated pipit** feeding on the banks of the river some 1400 miles south of Cairo. Less than a year before I had seen this bird in its breeding haunts beyond the arctic circle in Russian Lapland, and I knew that it only nested north of the tree-limit. When I recalled my own journeys by boat and rail round the North Cape and then again down to Khartoum, and looked at the lonely, delicate little bird before me, it was almost impossible to realise that those feeble wings would in a few weeks' time be transporting that tender little body beyond the arctic circle.

I have said that we rested in the heat of the day, but a variety of causes generally kept us busy. There were birds to skin and label and pack, and notes to be written, then a gun was always kept handy, even at meal times, for the unknown birds which would often come unwarily into the tree over our tents and proclaim themselves by their notes. There were sheikhs to be salaamed and interviewed, and then our own followers required much attention. They stole from the natives, who naturally complained, they neglected the animals and the few duties we were able to put upon them, they were continually drunk with "boozer," and were always quarrelling and threatening one another's lives. All these little affairs had to be enquired into and dealt with during the mid-day "rest." Correction had to be administered usually in the form of the "korbag," laid on with no sparing hand by a companion of the delinquent. But they were accustomed to this, and a more effective form of punishment, reserved for special occasions, was to administer a kick with precision and power as though one were "placing" a goal at Rugby football. This not only hurt and surprised, but had the additional advantages of wounding the dignity of the kicked, and of bearing gratifying results to the kicker. Catering for ourselves and our followers also had to be attended to, and this sort of conversation would often ensue:—"Hassan, why have we no eggs in this camp when there is a village quite close?" "Ah, effendi, dey no buy (sell) eggs in dis village, all dee people want to make dee chickens."

To sleep during the mid-day rest was somewhat difficult. The temperature in the shade ranged from 100° to 115° Fahrenheit during the hot hours. There were also innumerable insects of various sorts in every camp. Ants of several kinds ran over us and bit us in the day time as well as at night. There were mosquitoes, sand flies and small biting beetles in most places, while huge hairy spiders and enormous hairless ones of ferocious attitude and powerful jaws often ran about inside our tents, but luckily these never preyed upon us. In one camp we were assailed by a whole army of little bees, which were extremely diligent in building small cocoon-shaped nests of mud in our bedding, boxes and clothes. At night the nests were tenanted by their builders, which resented a disturbance of their hardly-earned rest, and used their stings so freely that we were obliged to search carefully for the nests and burn out the defenders. Large black hornets were numerous, but inoffensive if not molested.

We yearned to catch and train one of the brilliant plumaged bee-eaters, of which there were four kinds in the country, to attend upon us and protect us from these noxious insects. A bee-eater fears no insect. I saw one of a small variety†† sitting on a twig suddenly dart into the air and catch a great hornet in the tip of its long bill. Returning to its perch with this delicate morsel, the bee-eater crushed it thoroughly by passing it to and fro through its beak and then suddenly swallowed it whole. In our camps furthest to the south white ants were a scourge and their ravages had to be carefully guarded against. All the baggage had to be moved and examined two or three times a day, and so quickly do these pests get to work that during a single night any article left lying on the ground will be completely covered with the sandy secretion, under which the ants operate, and will be half destroyed. Where these ants were numerous the trees were entirely brown with their workings, and the fallen trunks and boughs were not only brown with the protective covering but

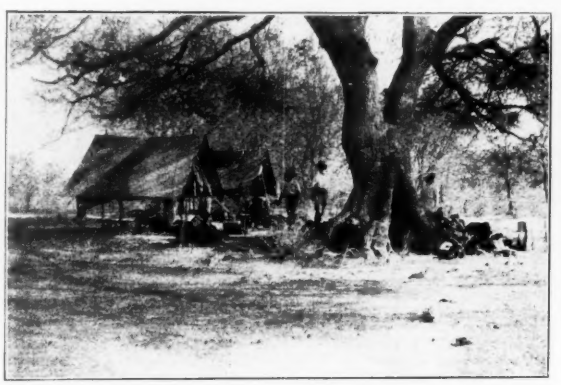

Fig. 2.—Camp at Gerazi.

eaten through, so that at every step on an apparent mound of earth one crushed through the shell of a fallen tree.

The most amusing visitors to our camp were the monkeys, which were numerous between Duem and Kawa. They were very tame and used to come regularly into the tree over the tents, and after a tremendous romp, would nestle up to each other and sleep for hours.

** *Anthus cervinus* (Pall.).

†† *Merops pusillus*, P. L. S. Müll.

They were grivet monkeys,‡‡ of a beautiful greenish-grey on the back, with whitish breasts, and black faces adorned with handsome white whiskers. We noticed that they were very fond of the gum which exuded from the acacia trees. But mammals of any kind were scarce in the country we worked, and we did not travel far enough south for big game. Occasionally a gazelle or an antelope would be seen, but they were rare and shy. In two or three places there were hares, and it was while I was chasing a wounded hare through some rough grass that I came across the only bird new to science which we discovered. This was a tiny fantail warbler,§§ of a most delicate light sandy colour on all the upper parts and with a silvery breast—a colouring most suitable for the brown grass and sandy country which it inhabited. I only obtained one specimen, and it is somewhat risky to found a new species on a single example, but the Hon. Charles Rothschild has lately obtained an exactly similar bird near Shendy, so that the claims of my new species may now be considered as established.

The photographs, with which this series of articles is illustrated, were taken by Mr. C. F. Camburn, to whom I am much indebted for permission to make use of them.

PLANT-BEARING HAIR.

By R. Lydekker.

Although the name "sloth" is not unfrequently misapplied by travellers to the slow lemurs of India and the Malay countries, or to their cousins the galagos of Africa, it should, as many of my readers are doubtless aware, be restricted to certain peculiar mammals inhabiting the tropical forests of Central and South America. In addition to the simple character of their teeth, which are confined to the sides of the jaws, sloths are characterised by their short faces, rudimentary tails, shaggy coats, and hook-like claws by means of which they hang suspended, back-downwards, from the branches of the trees among which their lives are spent. Two very distinct types of these animals are known, readily distinguished by the number of toes on the fore-limb. In the one form—the three-toed sloth—there are three claws on each foot, both in the front and the hind limbs. But in the other—the two-toed sloth—there are only two claws on each of the fore-feet.

These, however, are by no means the only differences between the two types (and I say types rather than species, because it is quite probable that each modification has more than a single specific representative). In the first place, there is a difference in the form and position of the first tooth in each jaw. In the three-toed sloth, or aï, for instance, this tooth is similar in form to those behind it, from the first of which it is separated by a space not longer than the one between the second and third. In the two-toed form, on the other hand, the first tooth is taller than those behind, and has a bevelled, instead of a flat grinding surface, while the space dividing it from the second much exceeds that between any of the others. Again, the front of the upper jaw of the two-toed sloth carries a T-shaped bone, corresponding to the pre-maxillæ of other mammals, which is totally wanting in the other form. The front of the lower jaw of the former is also prolonged so as to form a kind of spout, of which there is no trace in the latter. In both these respects the two-toed sloth comes much nearer to the extinct ground-sloths (of which we have lately heard so much) than is the case with its three-clawed cousin.

Again, if the males of the three-toed sloth be examined, there will be seen a patch in the middle of the back where, owing to the absence of the long coarse external hair, the presence of a soft orange and brown under-fur is shown. It has been stated that this patch of under-fur is made visible by the animals rubbing their backs against boughs and wearing off the long hair, but it seems much more probable that it is a sexual character. Of this under-fur the two-toed sloth has but a very imperfect development.

Apart from its extremely coarse and brittle nature, the most striking peculiarity of the outer hair of the sloths is its more or less decidedly green tinge. To see this in perfection it is necessary to examine living animals, as it tends to fade away more or less completely in skins which have been long exposed to the light, leaving the hair of a pale greyish brown colour. The green tint is, however, still distinctly visible in a pair of mounted specimens displayed to the public in the Natural History Branch of the British Museum.

Now green is a very rare colour among mammals, and there ought therefore to be some special reason for its development in the sloths. And, as a matter of fact, the means by which this coloration is produced is one of the most marvellous phenomena in the whole animal kingdom—so marvellous indeed that it is at first almost impossible to believe that it is true. The object of this peculiar type of coloration is, of course, to assimilate the animal to its leafy surroundings and thus to render it as inconspicuous as possible; and when hanging in its usual position from the under side of a bough, its long, coarse, and green-tinged hair is stated to render the sloth almost indistinguishable from the bunches of grey-green lichens among which it dwells. And if the physical means by which this green tinge in the hair of the sloths is produced be little short of marvellous, what is to be said with regard to the inducing cause of the phenomenon? But of this anon.

If a few hairs of the aï be examined under the microscope by a person familiar with the structure of hair in general, it will be found that while the central portion consists of what is technically known as cortex (and not of the medulla which forms the core of the hair of many mammals), the outer sheath is composed of an altogether peculiar structure, for which the somewhat cumbersome name of extra-cortex has been proposed. Possibly it may correspond to the thin cuticle of more ordinary hairs; possibly not—either way, it need not concern us further on this occasion. In old and worn hairs this outer sheath (as it will be more convenient to call it) becomes brittle and breaks away piecemeal, leaving the central core alone.

But in ordinary circumstances the sheath tends to form a number of transverse cracks, and in these cracks grows a primitive type of plant, namely, a one-celled alga.* And for the benefit of non-botanical readers it may be well to mention here that algæ (among which sea-weeds are included) form a group of flowerless plants related on the one hand to the funguses and on the other to the lichens. The majority live in water—

‡‡ *Cercopithecus sabaeus* (Linn.). §§ *Cisticola aridula*, Witherby.

* The presence of algæ in the hair of sloths has been long known to science, but the whole subject has recently been re-investigated by Dr. W. G. Ridewood (*Quart. Journ. Microscopical Science*), and it is the appearance of his communication that has suggested the present article.

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either salt or fresh—comparatively few deriving their nourishment from the moisture contained in the air. Some, indeed, are confined to particular descriptions of rock, and possess structures recalling roots, but even in these cases it is doubtful if they draw more than an insignificant fraction of their nutriment from the substance on which they grow.

In the moist tropical forests forming the home of the sloths, the algæ in the cracks of their hairs grow readily, and thus communicate to the entire coat that general green tint, which, as already said, is reported to render them almost indistinguishable from the clusters of lichen among which they hang suspended.

"In thick transverse sections of the hair," writes Dr. Ridewood, "these algal bodies show up very clearly, since they stain deeply, and have a sharply defined circular or slightly oval outline. Unless the hair is much broken, they are confined to the outer parts of the extra-cortical layer."

Not the least curious phase of a marvellous subject is that the two-toed sloth, although the structure of its hair is very different from that of the aï, also has an alga, which belongs to a species quite distinct from the one found in the former.

In the two-toed sloth the hairs lack the outer sheath investing those of the aï, and consist chiefly of the central core of cortex; in other words, they correspond to those hairs of the latter from which the outer sheath has been shed. The surface of these hairs is distinctly furrowed with longitudinal grooves or channels, and it is in these channels that the alga distinctive of this particular species is lodged and flourishes. After stating that a solution capable of exhibiting the absorption bands of the vegetable colouring matter chlorophyll can be obtained from the hairs of this animal, Dr. Ridewood gives the following particulars with regard to their structure:—

"The hairs are, as a rule, coarse, and with a single curve extending over the greater part of the length, while the basal fourth or so is wavy; but in young specimens, and in some apparently adult examples from Costa Rica, the hair is very delicate and soft, and sinuous from base to point. However, in these forms the hairs . . . . have only two or three furrows instead of the more usual nine, ten, or eleven. The algæ, also, are quite absent from many of the grooves. When such an empty groove is examined in optical section it exhibits the outlines of obsolete extra-cortical cells. . . . . In baby specimens more than half of the hairs are slender non-medullate cylinders, with a very distinct scaly cuticle, and no grooves on the surface."

These simple hairs are, in fact, the only rudiments of an under-fur possessed by the two-toed sloth, or unau.

It may be added that in the presumably extinct ground-sloths (the skin of one of which has fortunately been preserved to us in a cave in Patagonia) the hairs are solid, without (according to Dr. Ridewood) any trace of the outer sheath of those of the aï, or of the flutings characterising those of the unau. These are thus evidently of a less specialised type than is the hairy covering of the modern tree sloths, as indeed would naturally be expected to be the case in the members of the ancestral group to which the latter probably trace their descent.

The above, then, are the essential facts with regard to the peculiarities of their hair by means of which the sloths are brought into such special and remarkable harmony with their environment, and it now remains to consider how best to explain their origin.

Of all the problems with which the naturalist has to deal those connected with the "mimicry" of one animal by another, or the special resemblances by certain animals to their inanimate surroundings, are some of the most difficult, and the present instance forms no exception to this rule, if it is believed that "natural selection," or some such mode of evolution, has been the sole factor in the case.

In this instance, at any rate, there can be no question as to any volition on the part of the animal concerned having aided in the development of its protective resemblance. And, on the hypothesis of natural selection, it appears necessary to assume that when the modern types of sloth were first evolved no alga grew in the hair of these animals, which were consequently able to exist and flourish without any such adventitious aid. The nature of their hair formed, however, in the case of each of the two groups, a convenient *nidus* for the lodgment and growth of an alga; and such a suitable situation was accordingly in each instance seized on as a habitat by one of those lowly plants. At first, of course, only a certain number of sloths would have had alga-producing hair, and these, from the green tinge of their coats, would consequently enjoy a better chance of escape from foes than would their brethren which had not yet acquired the greenish garb. And, on the assumption that alga-growing hair is inherited, their progeny would consequently have the best chance of winning in life's race. It is, of course, not difficult to assume that when the alga had once become firmly established as part and parcel of the hair of each group it acquired in both cases distinct specific characters, even if there were not originally two kinds of these plants concerned.

And here arises one of the many difficulties connected with this sort of explanation. It is quite clear that an alga would have been of no advantage to the sloths until they had acquired their present completely arboreal kind of life, and since there is a considerable probability that both types of these animals were independently derived from some of the smaller ground-sloths, it follows that on two separate occasions an alga has independently taken advantage of this suitable vacant situation and adapted itself to its new surroundings. This difficulty, like the one connected with sloths having flourished before they acquired a lichen-growth, may appear of little importance to those who are convinced of the all-sufficiency of natural selection, but to others it may (if well founded) seem more serious.

As we have already seen, the structure of the hair in the two types of sloth is, each in its own way, absolutely peculiar, and has therefore doubtless some special purpose. And, to put it shortly, the question consequently is whether these two types of hair structure were specially developed for the reception and growth of algæ designed to aid in the protection of the animals on which they occur, or whether such development has taken place for some totally different object, and that the subsequent growth of the algæ, and the additional protection thereby afforded, have been purely fortuitous. The fact that the hairs themselves assimilate the body of the sloth to a lichen-clad knot, shows that their peculiar character is largely protective, and it would be a most curious coincidence had this protective

resemblance been enhanced by an accidental growth of algæ.

As regards the manner in which the growth of algæ is maintained in the sloths from one generation to another, the only rational explanation which presents itself is that the young sloths become infected with alga-spores from their parents. As already mentioned, Dr. Ridewood has pointed out that in very young individuals of the two-toed sloth a large proportion of the hairs are devoid of grooves; and it would therefore seem that the young sloths do not develop a growth of alga till about the time they are old enough to leave the maternal arms and hang independently on the leafy and lichen-clad boughs of their native forests.

THE TOTAL SOLAR ECLIPSE OF MAY 18, 1901.

By E. Walter Maunder, F.R.A.S.

The striking success which attended the observations of the eclipses of 1898 and 1900 has gone far to make people forget that conditions so favourable are very rarely obtained. On both occasions we had the shadow track passing for an immense distance through settled and civilized countries easily reached from abroad, and where all necessaries and conveniences could be readily procured. On both occasions, too, a great number of expeditions were organized, and many observing stations occupied, and everyone, without exception, enjoyed fine weather. This must be regarded as most phenomenal good fortune, which it was against every probability would be soon repeated. There is therefore no need to feel disappointed that the same unusual degree of success did not attend the eclipse of last May. It was one of specially long duration, but its geographical conditions were of the tantalizing character which are almost inseparable from such. The shadow track lay near the equator, and this being so, it was inevitable that much of it should lie across the open ocean or countries neither accessible nor civilized. Broadly speaking, only two limited regions were sufficiently accessible to tempt astronomers. For the eclipse at morning, the islands of Bourbon and Mauritius were available; whilst the west coast of Sumatra had it in the early afternoon. A French expedition, under M. Deslandres, went to Bourbon; whilst Mrs. Maunder and myself went to Mauritius. But the chief stream of observers flowed to Sumatra, attracted, no doubt, by the unusual length of totality there; and some eight or ten distinct expeditions, English, American, Dutch and Japanese took up their stations at Padang or within a few miles of it.

This limitation of observation to two very restricted areas stands in great contrast to the experiences of 1898 and 1900; but it cannot be doubted that it was imposed upon astronomers by the conditions of the case, and a similar limitation has been found imperative in the majority of eclipses.

As I have not yet had the opportunity, since my very recent return to England, of learning much as to the details of the results obtained by the numerous parties in Sumatra, I must restrict my present account entirely to the Mauritius observations.

From its situation, far out in the Indian Ocean, and nearly under the Tropic of Capricorn, Mauritius is in an extremely favourable position for the study of the great movements of the atmosphere. To the north of the island lies the equatorial belt of calms, with its hot, damp and rarefied atmosphere; to the south, tropical calms characterized by their cool dry atmosphere and high barometric pressure. These two belts do not remain in a fixed position but move northward or southward with the sun. Mauritius therefore comes at one time of the year into the one belt, and six months later into the other, whilst for the greater part of the year the island lies in the track of the south-east trade winds. During the period that the sun is vertical, or nearly so, over the island, there is a liability to fierce cyclonic disturbance, the actual centre of which may or may not pass over the island, but the passage of which may make itself sensible even at the distance of hundreds of miles. Further, beside the observations which can be made on the island itself, it stands in the great highway from the Cape of Good Hope to India, a highway which was for long the chief route from England to India. It therefore was, and still is to some extent, a place of call for a large proportion of the vessels navigating the Indian Ocean, and the logs of the ships putting in here afford the means for ascertaining the general state of the weather over the entire ocean.

This favourable position drew the attention of a traveller, Mr. C. Meldrum, who half a century ago had the misfortune to be wrecked on Mauritius on a voyage from India to the Cape. From this time he made the

Fig. 1.—Royal Alfred Observatory, Mauritius. The group of trees on the left-hand side of the picture had to be cut down to a height of 16 feet in order to give a clear view of the Eclipse.

island his home, and the study of the atmospheric disturbances of the Indian Ocean his life work. He founded the Meteorological Society of Mauritius in 1853, and was for many years its secretary; he collected and copied the logs of as many of the vessels as called at Mauritius as he could obtain; he procured the establishment, first of a modest meteorological observatory in Port Louis, the capital, and later, as the value of his researches became better known and more appreciated, of a larger and more completely fitted one at Pamplemousses, some seven miles to the north. The foundation stone of this new institution was laid by H.R.H. Prince Alfred, Duke of Edinburgh, during his visit to the island in 1871, and it still bears his name.

The selection of Pamplemousses as the site of the new observatory has proved a most unfortunate one. This could not have been foreseen at the time when the erection of the observatory was resolved upon. Mauritius was then, except for a few sporadic cases, quite free from malarial fever, and the broad level plain

not only offered a good horizon in almost every direction, but was the chief residential district of the island, and as it still is, the most fertile. But in 1867 there was a virulent outbreak of malaria, and before the Observatory was completed, it had become endemic in Pamplemousses, and the European population had been driven away and forced to seek refuge in the higher country on the further side of the capital, and the gateways of old country houses and widespreading yet crowded cemeteries alone remain to testify to the former popularity of the district.

The chief purpose of the observatory was, of course, meteorological; the study of the laws of storms, and the prediction of cyclones, the chief items in its programme. But astronomy was not neglected, and it was furnished with three instruments of respectable size and quality. These were a transit instrument of 3-inches aperture, an equatorial of 6-inches, and a photoheliograph of 4-inches. The existence of an observatory of this size and situated close to the very centre of the shadow track was a circumstance that could not be overlooked in the choice of stations from whence to observe the eclipse.

There was a yet further reason why the Astronomer Royal should have selected the Royal Alfred Observatory, Mauritius, as one of the stations to be occupied by one of the eclipse expeditions which he was sending out. The Director, Mr. T. F. Claxton, F.R.A.S., and his chief assistant, Mr. A. Walter, were both former members of the staff of the Royal Observatory, Greenwich, and an intimate connection has been kept up between the two observatories for the last seventeen years, in that the photographs of the sun taken at Mauritius, so far as they are required for the completion of the Greenwich series, are regularly sent to the latter observatory for measurement and reduction.

In coming to Mauritius, therefore, we came to friends and colleagues, who welcomed us as such, and who

Fig. 2.—Mr. Claxton's Station at the Eclipse, showing the Mauritius Photoheliograph and the Rapid Rectilinear Camera mounted horizontally in connection with the 16-inch Cœlostat.

spared no trouble or pains to secure the success of our work. We reached the island on Saturday, April 20, and on the following Wednesday took up our residence at the Observatory, not without many warnings from Government officials medical men and friends that we were doing a very risky thing. It was a risk, however, that we were obliged to face. We were bound to use to the uttermost the advantages offered by the instruments and buildings of the Observatory, so that we were precluded from seeking an eclipse station elsewhere in the island; and we could not make the Observatory our station unless it was to be also for the most part our home. For from the Observatory to the healthy country on the central plain of the island is a journey of more than two hours' length by road and rail, and the trains only run during the hours of daylight. If we had lived away from the Observatory, therefore, our working hours would have been very short, and it would have been impossible to make use of the stars for focussing and other adjustments of our instruments.

We were not at all inclined to regret this necessity

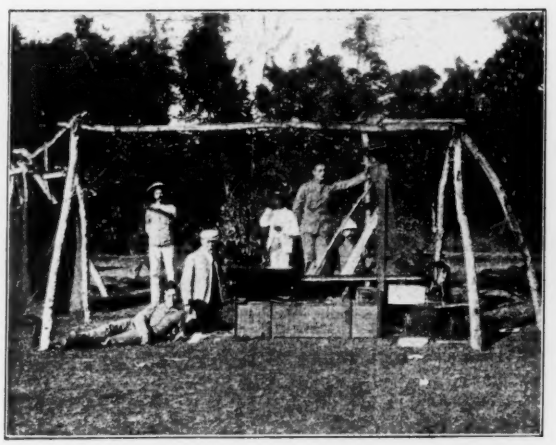

Fig. 3.—Mr. Maunder's Station at the Eclipse, showing the Greenwich Coronagraph and the Evershed Prismatic Camera mounted in connection with the 12-inch Cœlostat.

at first. The Observatory is a handsome building, standing in eleven acres of its own ground, and its surroundings are very pleasant to the eye. The climate was hot, damp and somewhat enervating, but being tempered by the breeze which sprang up every day soon after noon, was far from being unpleasant. A more serious drawback lay in the difficulty of getting sufficient manual assistance, though this was partly overcome by the kindness of the military authorities, who allowed five non-commissioned officers from the garrison who had volunteered for this work to come down for one day to unpack our instruments, and nine to assist us in the observations on the day of the eclipse. A yet further, and most important help was that one of these —Staff-Sergt. Ralph Smith, A.O.C.—was allowed to place his services at our disposal pretty nearly continuously for the three weeks preceding the eclipse, and to his skilful hands we confided the care and treatment of the driving clocks of our telescopes and cœlostats.

The programme which Mr. Claxton and myself proposed to carry out in combination, comprised the photographing the corona with three instruments, all of the same aperture, but of very different construction and size of image, so as to secure delineations as perfectly as possible of its three chief regions. The photoheliograph of the Mauritius Observatory was the first of these, and gave an image of the sun nearly eight inches in diameter. With this instrument only the prominences and the very lowest region of the corona could be obtained. Next came the Greenwich coronagraph, giving an image 2¼-inches in diameter. With

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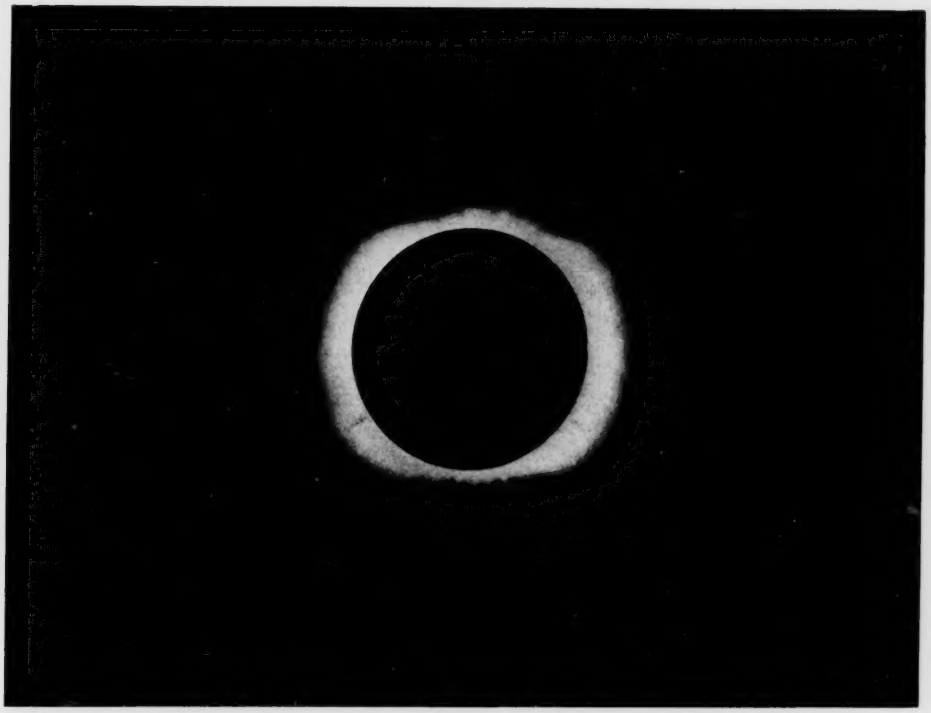
NORTH.

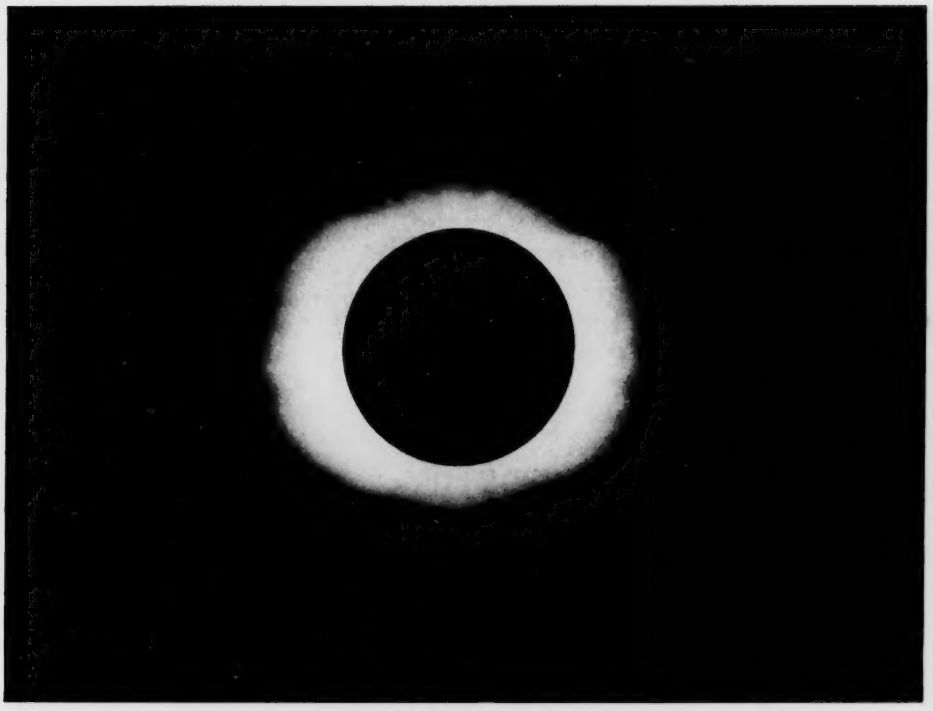


WEST. EAST.

SOUTH.

Exposure, 2 seconds; Time, 22 seconds after Second Contact; Plate, Imperial "Fine Grain."

NORTH.



WEST. EAST.

SOUTH.

Exposure, 8 seconds; Time, 145 seconds after Second Contact; Plate, Imperial "Fine Grain."

THE CORONA OF 1901, MAY 18.

Photographed at the Royal Alfred Observatory, Mauritius, with the Newbegin Telescope; 4¼ inch Cooke Photo-visual Object Glass; Focal Length, 71 inches.

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this the corona in general was sought to be secured, whilst with a Rapid Rectilinear lens by Dallmeyer, giving an image of 0.3-inches, the outermost extensions were aimed at. These three instruments, together with a prismatic camera, lent to the expedition by Mr. Evershed, were not pointed up to the sun, but were mounted in a horizontal position, the light from the eclipse being reflected into them by means of a cœlostat. The Mauritius photoheliograph and the Rapid Rectilinear lens were mounted the one under the other in

Fig. 4.—Our Military Helpers.

connection with one cœlostat, which had a mirror of 16 inches diameter, the prismatic camera and the Greenwich coronagraph in connection with a second, furnished with a 12-inch mirror.

Mrs. Maunder's programme and equipment were entirely independent of the foregoing. Her first purpose was to repeat with the same instruments the photographs obtained in India in 1898, and in Algiers in 1900, and she consequently brought the stigmatic lenses and the "Niblett" eclipse camera belonging to the British Astronomical Association which had been used on those occasions. The great kindness of Mr. Newbegin, F.R.A.S., furnished her also with the beautiful photo-visual telescope which Mr. Thwaites used in 1898 in India, and as its aperture was little over 4-inches, and the diameter of its image 2/3 of an inch, the photographs obtained with it supplement most usefully and instructively the threefold series of the official programme. The equatorial and camera bequeathed by the late Mr. Sidney Waters to the Royal Astronomical Society, and used in the last two eclipses, were also both part of Mrs. Maunder's equipment.

The weather on the morning of the eclipse was the most favourable of any morning since our arrival at Mauritius. A heavy bank of clouds did, indeed, hide the first contact from us, but this had passed and the light scud that followed it had also entirely cleared away before the eclipse became total. The sky was completely clear therefore during the fateful minutes, but not with anything like that purity and transparency with which we had been favoured on the two last occasions. Indeed, at Curepipe, some fifteen miles away, the whole spectacle was completely lost through cloud, and at Quatre Bornes, twelve or thirteen miles distant, a fine drizzle—locally known as "Moka dust"—fell during totality from a sky apparently clear, and gave to the fortunate watchers located there the unique spectacle of an "eclipse rainbow," a rainbow due to the corona and prominences.

This want of perfect clarity in the atmosphere is no doubt the reason for the following unmistakable result. It will be remembered that after our success with the little stigmatic lens in India in 1898, we set ourselves to ask the question as to whether the exposure of 20 seconds which we had then given was the longest which could be given with advantage. The answer in 1900 was that an exposure of 48 seconds had no advantage as to length of coronal streamers shown over an exposure one-sixteenth that duration. The answer to the same question as asked in Mauritius was more decisive still in the same direction. The longest streamers that we obtained were due to the Newbegin telescope, and correspond to about a second's exposure with the stigmatic lens. This result is not the one we should have liked to have got, but a result is always worth getting whether it accord with one's predilections or not. The result we obtained is not the solution of the problem as to whether the actual length of the coronal streamers varies from eclipse to eclipse, but only that, for this eclipse, our longest exposures exceeded that of greatest efficiency under the actual atmospheric conditions.

As a series the finest set of photographs we obtained were the fourteen taken by Mr. A. Walter during totality with the Newbegin telescope, two of which are reproduced in the accompanying plate. It is sufficiently well known that the corona is by far the most difficult object for photographic reproduction, and any photo-mechanical process such as that employed for the plates in Knowledge necessarily fails to do more than exhibit the general distribution of light in the corona; its delicate details completely elude representation. Yet full as the original photographs are of beautiful detail—and as pictures of the lower corona, I do not think that finer photographs than these and some of those taken with the Greenwich coronagraph have ever been obtained—the corona, as a whole, must be pronounced as

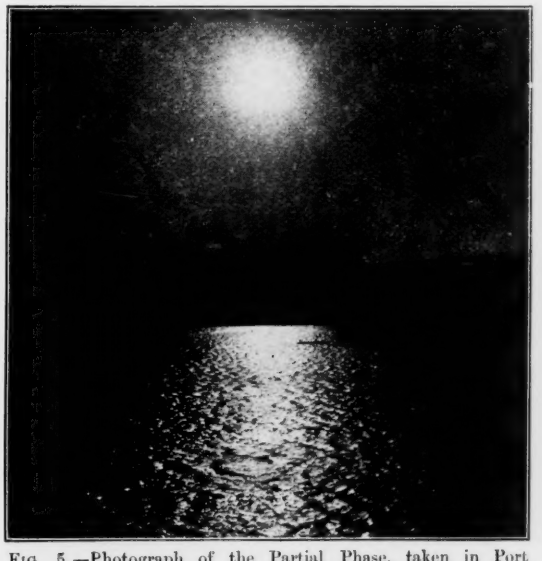


Fig. 5.—Photograph of the Partial Phase, taken in Port Louis Harbour by the Chief Officer of the s.s. "Ugina."

distinctly simpler than that of last year; it is of a yet more pronounced minimum type. It is confined even more strictly to the four same regions; the east and

west equatorial wings parallel to the equator, and the groups of radiating plumes round the north and south poles. But the equatorial extensions are even more strictly than in 1900, parallel to the equator, and the polar plumes are fewer and more distinct.

It is no good quarrelling with a minimum corona because it is a minimum corona; we have to accept the fact that it is of a comparatively simple structure and learn the lessons which that fact has to teach.

Yet even this corona, at a time of almost utter sun-spot stagnation, shows, though more feebly than the two preceding eclipses, the synclinal curves rising from the prominence regions and terminating in narrow rod-like rays. And as in 1900, the corona is still invaded by what would appear to be "dark rays," though these are less clearly distinguishable from mere rifts than in that eclipse.

Upon the more routine observations it is not necessary now to enlarge. The times of the second, third and fourth contacts were successfully determined by three independent observers at the Observatory, and by a fourth, Capt. Robertson, of the British India s.s. "Ugina," at Port Louis, to whom we are indebted for the accompanying photograph of the partial phase taken by his chief officer from the deck of the vessel. Mr. Claxton also took a very fine series of thirty-four photographs of the partial phase with the Mauritius photoheliograph on a scale of eight inches, for the moon's diameter and place. And the list of photographs may be concluded by one which, though of no scientific value, is certainly unique, namely, a photograph of the corona taken with a pinhole camera belonging to Mrs. Maunder, aperture 1/32 of an inch, focus 33 inches, and exposure 3½ minutes on an Imperial Special Rapid plate.

CONSTELLATION STUDIES.

By E. Walter Maunder, F.R.A.S.

IX.—THE SEA-MONSTER AND THE FLOOD.

In our Constellation Study for June, I drew attention to the familiar fact that so many of the forms of the primitive constellations are duplicated, and that when thus repeated, the twin symbols are, as a rule, not widely separated, but placed close together. The bird region on the Milky Way is a remarkable instance of this. But a still more striking one is found in the portion of the heavens which we have now reached. We are in the midst of the signs of fish and water.

The first token of these marine symbols occurs in the pretty little constellation of the Dolphin that coils itself behind the outstretched wing of the Eagle. Then follows the fishtail of Capricorn. Next we have Aquarius, with the broad stream flowing from his ewer, and the Southern Fish at his feet. Aquarius is succeeded on the Ecliptic by the long constellation of Pisces, a pair of fishes united by a waving riband. Below this group two other constellations repeat in more terrible form the design of the water-pot of Aquarius. A huge marine dragon known to us to-day as Cetus, the "Whale," but traditionally rather of saurian form, like the

> "Monstrous eft that of old was lord and master of earth,"

pours forth from his mouth a vast bifurcating flood, which sweeps down below the horizon.

It is impossible to suppose that the association of these seven watery constellations in such close connection with each other can possibly be accidental. We may dismiss at once the idea that they have any special reference to the rainy season, for an eighth water constellation is supplied us in Hydra, the Water Snake, which, with the seven just named, very nearly completes the circuit of the sky. We should therefore have to conclude that we were dealing with a climate which was rainy throughout the year, a circumstance not likely to be symbolized in this particular fashion.

Anything like an adequate discussion of the true significance of this grouping would lead us too far astray from our present purpose. Greek mythology saw in Cetus the monster which Neptune sent to destroy Andromeda, in punishment for the pride and insolence of her mother Cassiopeia, and this, of course, is the account of Aratus.

> "Mark where the savage Cetus, crouching, eyes
> Andromeda, secure in northern skies;
> The Fish and horned Ram his progress bar,
> Nor dares he pass the track of Phœbus' car."

Brown identifies Cetus with the Euphratean Tiamat, the spirit of Chaos, the enemy of the beneficent gods, and opposed to law and order; and he notes that the southern heavens are generally given over to creatures of like ill significance—Hydra, Scorpio, Lupus, Corvus, Canis—representing, with Cetus, perhaps six of the "Seven Evil Spirits" of Akkadian mythology.

To the eye, the principal stars of Cetus form the outline of a lounge chair, spreading over a vast expanse of sky, its length being 50°, its average breadth 25°. Though none of its stars are bright, Beta only being of the second magnitude, and Alpha about 2½, the general outline can be pretty easily followed. Proceeding from east to west, Kappa, Alpha, Gamma, Delta and Omicron mark out the headrest of the lounge chair, or if we prefer so to speak of it, the lower jaw of the monster. The body of the chair is carried on by Theta and Eta, whence the axis of the constellation curves down to Beta, the footrest of the chair, or the tail of the beast. The back leg of the chair is marked by Epsilon and Pi, in a straight line with Omicron; whilst Zeta, Tau and Upsilon, springing from Omicron in a graceful curve, mark the front leg. Only a few of the stars have distinctive names in common use at present. Alpha is known inappropriately as Menkar, the "Snout," as the title more strictly belongs to Lambda, the fifth magnitude star above it. Beta is Diphda, the "Frog," its full name being Diphda al Tania, the "Second Frog," the first being Fomalhaut. These two stars were grouped together by Aratus as well as by the Arabs.

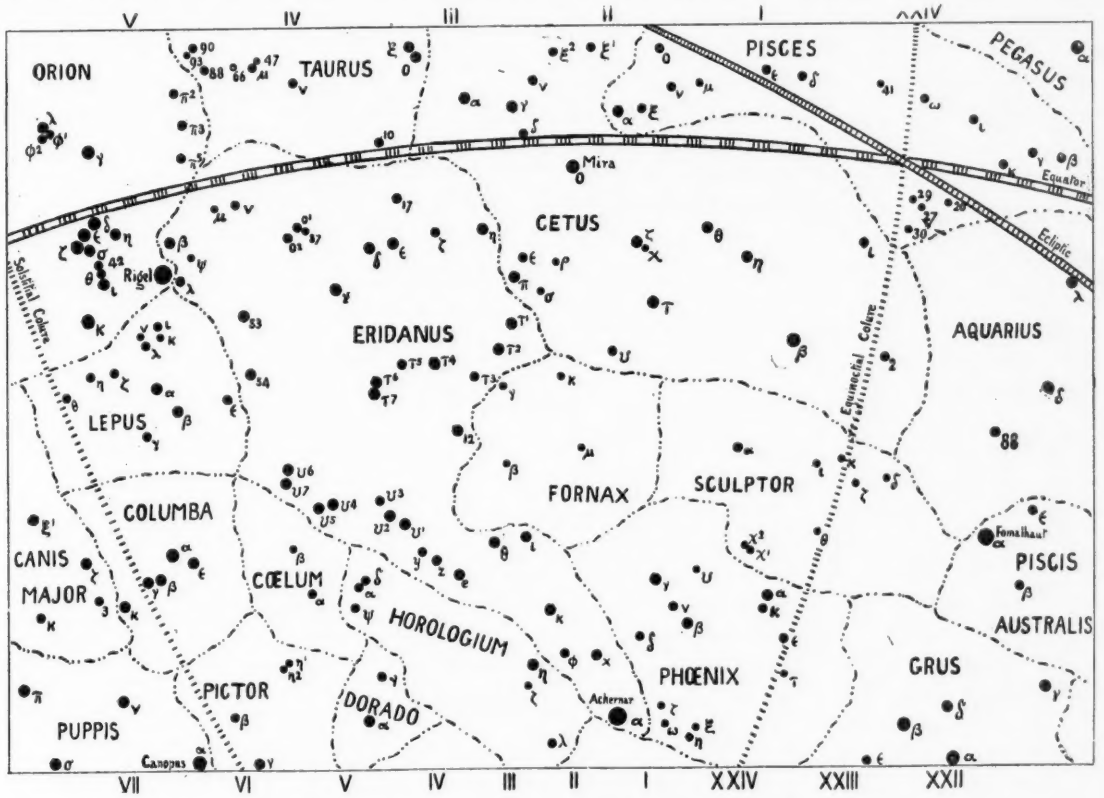
> "The southern Fish beneath Aquarius glides,
> And upwards turns to Cetus' scaly sides.
> Rolls from Aquarius' vase a limpid stream
> Where numerous stars like sparkling bubbles gleam;
> But two alone beyond the others shine;
> This on the Fish's jaw—that on the Monster's spine."

The star of Cetus is Omicron; its title of Mira, "Wonderful," being justly given to it because of its remarkable variations. It does not occur in Ptolemy's Catalogue, and the first recorded observation took place in 1596, when David Fabricius observed it as a third magnitude star. At its minimum it entirely disappears from the unaided sight, its brightness sinking down in the extreme case as low as magnitude 9½. Its maximum is usually about that of the third magnitude, but it has been known almost to equal Aldebaran. Its period of variation occupies eleven months, for about half of which it is invisible to the naked eye. Under ordinary circumstances, therefore, its brightness at maximum is four hundred times that at minimum half a year earlier; whilst its extreme range of brightness is four times as

great as this. Such a variation still baffles our every attempt to account for it satisfactorily; the explanation which obtains most currency, namely, that Mira is a dying sun, the surface of which from time to time is nearly hidden by enormous sunspots, is but a crude guess which leaves us still with many difficulties. It is certain that a variation in the case of our sun of but a tithe the amount of Mira's would leave this earth as bare of life as a meteorite, ere it had passed through a single course of its changes. Yet Mira is but the chief and representative of a large class of variable stars.

from the attack of the monster Typhon; clearly only an imperfect Greek rendering of an Euphratean tradition. The doubling of the fishes is supposed by Sayce, but manifestly without due cause, to be due to the double month Adar, that is to say, Adar with the intercalary month Ve-adar. The constellations must have been, and were, mapped out long before the division of the zodiac into the twelve equal signs of 30° each, associated with the months.

Although Pisces is a particularly dull constellation to the naked eye, its two brightest stars, Eta and Gamma,



Star Map No. 9; The Region of the Sea-Monster and the Flood.

The idea of Cetus as the persecutor of Andromeda is carried out on our modern star atlases by the intervention of the zodiacal constellation of the Fishes, and indeed the arrangement is warranted by the description which Aratus has given us in his poem—

> "Where the equator cuts the zodiac line
> On the blue vault, the glittering Fishes shine.
> Though far apart, a diamond studded chain,
> Clasping their silver tails, unites the twain.
> The northern one more bright is seen to glide
> Beneath the uplifted arm and near the side
> Of fair Andromeda."

The knot of the riband actually rests on the neck of the Sea-Monster, and as the riband stretches northward to the Northern Fish, the latter is often represented as playing the part of Cetus, and actually fastening on the side of his devoted victim, who might otherwise have smiled securely at the distant hate of the Sea-Monster. There does not appear, however, to be any sufficient traditional authority for this relationship. The classical legends identify the twin fishes with Aphrodite and Eros, who plunged into the Euphrates to escape

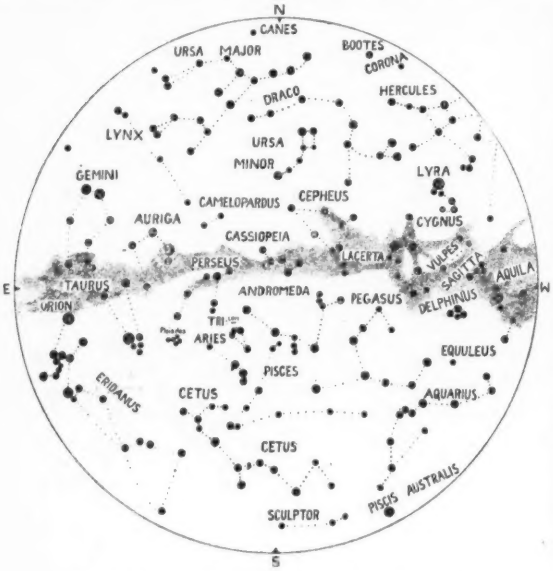
barely surpassing the fourth magnitude, it is an easy constellation to trace out, as it consists chiefly of a number of stars between the fourth and fifth magnitudes, arranged in two obvious streams. Alpha, the most easterly star of the constellation, is not far from Mira Ceti, and marks the knot where the two cords attached to the tails of the two fishes are tied. This is implied by its name Okda, from Okda al Kaitain, the "knot of the two threads."

> "The silken bands that join the Fishes' tails
> Meet in a star upon the Monster's scales.
> Beneath Orion's foot Eridanus begins
> His winding course, and reaches Cetus' fins."

The constellation of the Stream is a large but not specially well marked one. Aratus and Eratosthenes give it the name "Eridanus," and it seems extremely probable that the Akkadians identified it with the Euphrates as the Egyptians with the Nile. Brown considers that the name "Eridanus" may be a Turanian river name, meaning "strong river." The meaning of the placing of the river in this part of the heavens is

XUM

not apparent at first sight, since the story of Perseus and Andromeda, with which the Sea-Monster is connected, gives no record of a stream or river, unless we consider that the constellation refers to the flood, to cause the abatement of which Andromeda was sacrificed. If this be so, then no doubt Eridanus stands for the Great Deep of the Primeval Chaos of which the Sea-Monster typified the indwelling principle. Proctor has seen in the constellations surrounding Ara a note of the Hebrew account of the great Deluge, and it is



The Midnight Sky for London, 1901, October 4.

possible that in this flood of Eridanus which the Sea-Monster pours forth from his mouth, there may equally be a reminiscence of the same great flood which figures so largely in Babylonian tradition.

Only two of the stars of the constellation bear special names in common use to-day—Alpha Eridani, a bright star far below our English horizon, is now known as Achernar, meaning "the end of the river." In Ptolemy's Catalogue the star with the corresponding title is our Theta, a star some 17° further north. But apparently it was felt the constellation lost its meaning unless it was prolonged downwards to the horizon, and hence as new stars came into view with southern exploration, the constellation was prolonged to within 32° of the southern pole. Beta Eridani, the brightest star in the part of the constellation familiar to us, and close to Rigel, the bright star on Orion's knee, is sometimes known as Cursa, the "footstool" or "throne" of Orion.

Obituary.

PROFESSOR BARON VON NORDENSKJÖLD.

Professor Baron Adolf Erik von Nordenskjöld, the celebrated Arctic explorer, died very suddenly—he was in fact working in his laboratory on the day of his death—on August 12th last. Nordenskjöld was born on November 18th, 1832, at Helsingfors, the capital of Finland, where his Swedish ancestors had settled. His father, Nils Gustav Nordenskjöld, was a distinguished mineralogist, and it was probably during expeditions with his father to the Ural mountains and other regions that young Nordenskjöld first acquired his taste for travel, as well as for mineralogy. In 1849 he entered the university of Helsingfors, devoting himself chiefly to the study of mineralogy and geology. His political views being considered as unorthodox by the Russian authorities, he was forced to leave Finland, and in 1857 settled at Stockholm, but was permitted to return to Helsingfors in 1862. In 1858 he first visited the Polar regions, accompanying Torrell, as geologist, to Spitzbergen. In 1861 he again visited Spitzbergen with Torrell, while 1864 found him once more in that arctic island, the southern portion of which he mapped as well as completing the preliminary part of a survey for the measurement of an arc of meridian. His first expedition on a large scale was undertaken in the *Sofia* in 1868, when the high latitude of 81° 42′ N. was reached. Mr. Oscar Dickson, whose name has been always associated with that of Nordenskjöld as providing the funds for his most important expeditions, determined on a new expedition, which was to winter on the south-east coast of Spitzbergen, and thence to push north in sledges over the ice. With this in view the explorer proceeded to Greenland in 1870 with the object of testing and comparing the utility of dogs and reindeer as beasts of traction. In 1872 the new polar expedition at length started, but the ice conditions were extraordinarily unfavourable, the reindeer—chosen in preference to dogs—escaped, and Nordenskjöld was further handicapped by having the crews of some frozen-in walrus sloops depending upon him for subsistence. However, some good scientific work was done, and extensive journeys made over the inland ice of North-east Land. Nothing daunted by this failure, the explorer, with the help of Mr. Dickson, worked for the next few years on the exploration of the Siberian Polar seas. This work culminated in his world-renowned voyage in the *Vega*, when the north-east passage was first accomplished. Starting from Tromsö on July 21st, 1878, the *Vega*, accompanied by the *Lena*, passed through the Kara Sea, and on August 19th, rounded Cape Cheliuskin, the northernmost point of Asia. At the Lena delta the *Vega* parted company with her consort, which sailed up the mighty river, the name of which she bore. Proceeding slowly through increasing masses of ice the *Vega* continued her voyage alone, and was eventually icebound at the end of September off Pitlekai in 67° 07′ N., 123° E. During the long winter and spring the explorers carried on scientific observations, and it was not until July 18th, 1879, after 294 days' imprisonment, that they were again able to weigh anchor. Two days later the eastern extremity of Asia was rounded, and, proceeding down the straits, Yokohama was reached on September 2nd. On his return to Europe Nordenskjöld was greeted with the utmost enthusiasm. He was created a Baron in the Swedish Peerage, and many other honours, which the successful accomplishment of his adventurous voyage deserved, were bestowed upon him. In 1883 he undertook a second expedition to Greenland, after which he devoted himself to the study of Antarctic exploration. Although advancing years precluded him from visiting these regions himself, it must have been highly satisfactory to him to know that his nephew—Dr. Otto Nordenskjöld—was about to lead an expedition to the Antarctic regions. Besides the explorations for which he is chiefly famed, Baron Nordenskjöld's researches in mineralogy and geology were important, and he sat as a Liberal for many years in the Lower House of the Swedish Diet.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE DISTRIBUTION OF THE STARS IN SPACE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I have just been reading the able article on "The Brightness of Starlight" in the August number of Knowledge (by J. E. Gore, F.R.A.S.), and have been particularly struck with the very discordant results there obtained, by making use of Dr. Gould's formula, and the method adopted by Mr. Gore.

Now this subject of the Distribution of the Stars in Space is one that I have often thought about. I do not refer so much to the distribution of the stars according to "magnitude," as according to their actual "position" in space. Has anything yet been done towards the solution of this question, or if not, have data sufficient for dealing with the subject yet been accumulated?

I have a notion that some light may be thrown on the vast subject of "The Evolution of the Galaxy" by this means; and especially, may I add, by concentrating attention on the comparative sparseness or closeness of the stars at different depths, along the great circle of the galaxy. Arthur Ed. Mitchell.

Oxenhope, nr. Keighley.

[The investigation of the comparative numbers of stars in different directions in space, by means of "star gauges," presents little difficulty, but to determine in addition the relative numbers at different distances is a problem which cannot at present be completely dealt with, because of the want of data as to the distances of a sufficient number of stars. Actual measurements of stellar parallax are very few, and magnitude is no safe guide to stellar distance, so that we must needs make the best we can of proper motions as a key to the distances of the stars, the stars with large proper motions being supposed relatively near. Even with this basis, however, the distribution of only a few thousands of stars can at present be discussed; certainly not enough in themselves to indicate the form of our stellar universe. Evidence as to the construction of the heavens is, therefore, mainly indirect, and hence the many different views on the subject. Still, one fairly definite result arrived at by Prof. Kapteyn from a discussion of proper motions is that the sun is a member of a cluster of stars of the same type as itself, and that a denser ring of white stars, situated at a great distance outside this cluster, appears to us as the Milky Way.—Eds.]

SUDDEN BLANCHING OF HUMAN HAIR.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—In his paper on the whitening of the hair of animals, Mr. Lyddeker remarks that, from the evidence, the fact of rapid blanching of human hair from emotion must be accepted. It may interest him and some of your readers to know of a definite instance of this effect, not from emotion, but from disease. I have recorded it where it is not likely to be generally accessible ("Man, Dis. Nerv. Syst.," Vol. II.). A man, in consequence of an injury, had hæmorrhage over the greater part of the left hemisphere of the brain. During the next two days the hairs of his beard and moustache on the opposite side, the right, were observed to become paler and paler, until they were almost white at the time of his death on the third day. The change extended up to the middle line and there ceased. A very curious fact is that the pale region was separated from the normal brown, by a very narrow darker zone, almost black, in the middle line. Of course emotion must act by its profound derangement of the function of the cortex of the brain. Here we had a like effect produced by an organic influence, occurring under observation, within two days, and limited to the opposite side that which the disease would influence. The escape of the hair of the scalp, and affection of that of the face, may be ascribed to the special seat of the chief cerebral irritation. The hairs were made pale throughout their length. This, as an absolute fact, a result produced in two days, is significant. The only possible explanation is that the process, at the root of the hair, by which the normal pigment is produced, is so changed that a material is formed capable of discharging the colour of the pigment, and that this ascends the tubular hair and causes its effect, at least as far from the root as the length of the hairs on the face. The degree to which this chemical process is under the influence of the nervous system is strikingly obvious, but a similar action is treated on most of the secretory processes of the body. Tears are an illustration.

The dark line which limited the change is not easy to explain. We know that pigment is apt to accumulate at the limit of an area in which it is lessened, but we can hardly apply here the idea of any movement of pigment. It would rather seem as though, at the median line, at which the innervation of the two sides mingle, the defective influence of the one side, in some way, permitted that of the other side to become excessive. There are curious conditions yet to be worked out regarding the median blending of the nerve influence. In the lower part of the face the zone of coalescence is more considerable in extent and degree than in many other regions. W. R. Gowers, M.D.

A TRIPLE RAINBOW.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The remarks of your correspondent in the last issue of Knowledge on the subject of rainbows, recalled to my mind a very remarkable triple rainbow that was seen at Sutton-on-Sea on the 13th August at 4.20 p.m. A terrific hailstorm, accompanied by thunder and lightning, was in progress. In the direction of Louth and Grimolaby, the sun was shining through a cloudless sky, but, due west of Sutton, at an elevation of some forty-five degrees above the horizon, was a magnificent and well defined rainbow, whilst immediately underneath it, as it were, was another, which was not so intense or bright. A third was faintly visible underneath the last-mentioned, the distance separating the three being some $2\frac{1}{2}^{\circ}$. It seemed to me that there was more than one storm in progress at the time. G. McKenzie Knight.

43, Millman Street, W.C.

MOTHING IN SUFFOLK.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Take it altogether, August is generally my best month with lepidoptera, and I was not disappointed this year at Benacre, near Wrentham, in Suffolk. The commoner butterflies were revelling in the bright sunshine. Peacocks were numerous, and I was fortunate enough to take one with the small blue spot under the

eye-like mark in the hind wings. I may be wrong, but I flatter myself that I was the first to discover this variety of Io. I saw no clouded yellows in either clover or lucerne, and although I am told of good takes this year at Sheerness, especially of *hyale*, the pale species, I think it unlikely we should have two clouded yellow years in succession. One hairstreak (*T. quercus*) about completes my list of rhopalocera. With the *sphingidæ* I had a good time. It was a grand sight to see the huge convolvulus-hawk moths darting round and about the tobacco plants at dusk. Five or six were often there together humming like a hive of bees. They first appeared on the 20th, and kept it up all through the month. The females, though decidedly inferior in markings and antennæ, were always the largest, measuring some five inches from tip to tip. The specimens I took are so perfect that it is difficult to believe they are not home-bred. So far the moths of this species taken in Great Britain have been considered to be foreign-bred, but I have just examined a live pupa of *S. convolvuli*, in the possession of Mr. F. W. Frohawk, which is evidently a genuine specimen. The long trunk of the imago is very conspicuous in this pupa. This is, I believe, the first authenticated pupa of the convolvulus-hawk moth taken in Great Britain, though I have read in the *Field* and elsewhere of several reported takes of the larvæ. As regards the perfect insects we soon ceased taking them, yet they gradually diminished in numbers, and now I hear there are none; but according to my experience of their habits, they will assemble again at Benacre, in full force, about October. *Atropos* (death's head) larvæ were brought to me frequently, dug up while pulling potatoes. They are addicted to burrowing during the day, long before the final burial. Hence should be sought for at night, with a lantern, when they have emerged for a feed. It is curious what a large air-chamber this caterpillar makes under ground, in which to perform its two great transformations. If they are dug up it is better to force the pupæ in damp moss, and in a warm room, or otherwise they rarely survive the winter. I took both larva and imago of privet-hawk, also the larva of the eyed-hawk on an old willow. The beautiful little humming-bird moth was decidedly scarce this year, though it is generally a feature in the well-stocked Benacre gardens. Leaving the hawk-moths I come to the handsome tiger, drinker, and oak-egger, all of which my caddies brought me on the Southwold Golf Links. At light I took two species of thorn, viz., canary-shouldered and early. In a cover by the sea I took a perfect specimen of a female black arches, asleep on the trunk of a gigantic oak. Some years ago I took a male in the same locality. At sugar, red underwings appeared early, viz., 16th, but were never numerous. My great take was *C. fraxini* (Clifden nonpareil) on sugar on the 24th August. In my excitement in taking it I chipped the tip of the right upper wing. Otherwise it is a perfect specimen of this rare moth. With the lamp turned on, it showed to the full its grand expanse of upper, and gorgeous colouring of lower, wings, and it was a sight I shall not easily forget. For toads, hornets and wasps I was fully prepared, but a full-fed larva of the goat-moth on the sugar seemed to me out of place. JOS. F. GREEN.

Blackheath.

SUNSPOTS AND LIGHT.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In the *Proceedings* of the Royal Society, No. 446, page 295, Dr. W. J. S. Lockyer makes the following statement:—"It is generally conceded that the spots on the surface of the sun are the result of greater activity in the circulation of the solar atmosphere, and therefore indicate greater *heat* and, therefore, *light*. This being so, the curve representing the spotted area may be regarded as a light curve of the sun." I thing this statement is not quite correct. *Greater heat* may not imply more light, above a certain temperature the reverse is the case. Gas in an ordinary jet gives light; in the flame from a Bunsen burner, or in the cone from a blow-pipe, we have much greater heat and very little light. The flame of a spirit lamp gives greater heat than a candle, but it gives very little light. I think the sentence should read, "greater heat and, therefore, *less* light." Certainly the spots are much darker than the photosphere. Notwithstanding this, the analogy between the two curves may hold good with a different explanation. For similar reasons we need not regard the brightest stars as the *hottest*, probably the reverse is the case. A. ELVINS.

Toronto.

[Mr. Elvins raises questions which would take no small space for their discussion. It may certainly be granted that the sentence which he has quoted is, when taken by itself as it stands, extremely crude. We are not yet in a position to state unfalteringly that the sun gives most light at the sunspot maximum, or that its light varies with the spot curve. On the other hand, it is of course generally true that increase of heat means increase of light, the instances Mr. Elvins mentions notwithstanding. In the case of the sun, and we infer in the case of the stars likewise, the light proceeds for the most part from the photosphere, and this is considered to be a condensation surface. We might consider then that an increase of temperature would diminish the amount of condensation and so lessen the amount of light radiated. But it seems more probable that the actual effect would be simply to raise the level at which condensation took place, and therefore to form a greater radiating surface and one less affected by absorption from the sun's immediate surroundings; in other words, we should have an increase in the light. In the case of stars the brightness is obviously no guide to their temperature, since their brightness depends, among other things, on their distance. The relative temperatures of stars are therefore determined by comparing the intensities of their spectra in the violet and ultra-violet, not by comparing their stellar magnitude. —E. WALTER MAUNDER.]

Notices of Books.

"STAR ATLAS, with Explanatory Text." By Dr. Hermann J. Klein. Translated by Edmund McClure, M.A., M.R.I.A., F.L.S. (S.P.C.K.) Price 10s.—This excellent atlas of the stars is too well known to need extended notice. In the present edition the text has been revised and considerably enlarged, and the positions of the stars have been corrected to 1900. The notation for nebulæ now includes that of the New General Catalogue, as well as that of Herschel. For the benefit of readers as yet unacquainted with the atlas we may add that the maps cover the heavens from the north pole to declination 34 degs. south, and include all stars down to magnitude 6.5, as well as the principal clusters and nebulæ, while the text consists of useful notes on the various objects of interest which come within the range of moderate telescopes. Besides the star maps there are a number of views of clusters and nebulæ, but some of these might with advantage have been copied from photographs instead of from old drawings. While regretting that all reference to the Milky Way is omitted, both in maps and text, we cordially recommend the atlas to those desiring a trustworthy guide to an intimate acquaintance with the stars.

"ASTRONOMISCHER JAHRESBERICHT." Edited by Walter F. Wislicenus. Vol. II. 1900. Published with the aid of the Astronomische Gesellschaft. (Berlin: George Reimer. 1901.) Pp. xxvi. and 633.—The second volume of this most useful publication, which aims at giving a brief account of every astronomical book, article, or paper published in 1900, deserves the highest praise. No branch of astronomy is neglected, and every work published in a European language seems to have been included. The excellent classification of subjects, together with an index of names, makes it easy for the reader to find the literature relating to any branch of the science in which he may be interested, and the abstracts furnished give just enough information to enable him to judge of the importance of any particular contributions. Observations of comets and minor planets are brought together in a convenient tabular form. The present collection of references and notes differs from those provided by our various journals inasmuch as all contributions to the literature of astronomy, and not simply a selected few, receive notice, and, moreover, the work is much handier for purposes of reference. The editor, who appears to be himself responsible for the greater part of the volume, has done his work well and impartially, and deserves the thanks of all who are interested in the progress of astronomy. A copy of the book should find a place in every observatory and astronomical library.

"PLANT STUDIES. An Elementary Botany." By John M. Coulter, A.M., PH.D., University of Chicago. (Kimpton.) Illustrated. 7s. 6d. net.—If the whole of the "nearly one hundred volumes" of the Twentieth Century Text-Books which (as we are informed) it is intended to issue, are as interesting and beautifully illustrated as the present little book, we shall certainly welcome their appearance. The work does not consist of altogether original matter: portions of the author's "Plant Relations" and of his "Plant Structures" have been worked up and combined with new material; the result is a highly readable school text-book of botany viewed from an ecological and morphological standpoint, the letterpress simple and essentially practical, the illustrations numerous and instructive. Beginning with the leaves, the light relation is considered first, and subsequently their functions and structure. The remaining portions of the plant having been similarly dealt with, the plant in all its relations is considered, especial attention being drawn to the struggle for existence, and the question of food-supply. This leads to the consideration (in four chapters) of plant societies, a subject wisely elucidated by a wealth of illustrations from nature. Thence we pass to the great groups of the plant world: these are treated in a broad general way, suitable to the limitation of space which necessarily pertains to a book of the kind. We cordially recommend Prof. Coulter's "Plant Studies" to our readers.

"POISONOUS PLANTS IN FIELD AND GARDEN." By Rev. Professor G. Henslow, M.A., etc. (S.P.C.K.) 2s. 6d.—The object of this little book is "to enumerate and describe such of our common wild plants, as well as some frequently cultivated, which are at all likely to prove harmful to our little ones; who are only too apt to put everything which appears attractive into their mouths." But it is pointed out at once that many cases of plant poisoning are due, not to the irresponsible acts of children, but to the deliberate but mistaken action of adults; and to the latter the book is properly addressed. Following some preliminary ready remedies for poisoning, we find a chapter devoted to the structure of flowers and fruits, and another on the principles of botanical classification and nomenclature, to assist the unbotanical reader in the understanding of what follows. The remainder of the book is taken up with brief descriptions of the commoner hurtful plants arranged in the natural order, with a good deal of information concerning their poisonous properties, not unmixed with lore from the old herbalists, and occasional antidotes. Numerous cases of poisoning are described, forming reading which is sufficiently terrifying; and the prudent resolution of the average reader will, we fancy, be to try no experiments, and eat no vegetables but what he buys at his greengrocer's. The illustrations, which are numerous, are mainly drawn from Bentham's "Handbook of the British Flora"; while conveying a general idea of the plants described, they would be but little use in assisting the non-scientific reader to distinguish poisonous from non-poisonous species.

BOOKS RECEIVED.

Treatise on Zoology. Edited by E. R. Lankester, M.A., LL.D., F.R.S. Part IV. The Platyhelmia, Mesozoa, and Nemertini. By W. Blaxland Benham, D.SC. (LOND.), M.A. (OXON.). (Black.) Illustrated. 15s. net.

Use-Inheritance. By Walter Kidd, M.D., F.Z.S. (Black.) Illustrated. 2s. 6d. net.

Practical Mathematics for Beginners. By Frank Castle, M.I.M.E. (Macmillan.) 2s. 6d.

Plane Geometrical Drawing. By R. C. Fawdry, M.A. (Spon.) 6s. net.

Land and Fresh Water Shells. By J. W. Williams, M.R.C.S. (ENG.), F.L.S., F.R.M.S. (Swan Sonnenschein & Co.) Illustrated. 1s.

Clinical Pathology and Practical Morbid Histology. By T. Strangeways Pigg, M.A. (Strangeways & Sons.) 5s. net.

The Oxford and Cambridge History of England. By Roscoe Mongan, B.A. (Gill.) Illustrated. 1s.

Cowper's "Expostulation." With Notes by F. Knight Cracknell, M.A. (Gill.) 1s.

Notes on Agricultural Analyses. By T. S. Dymond, F.I.C., and F. Hughes. (Chelmsford: County Technical Laboratories.)

The Evolution of Sex. By Prof. Patrick Geddes and Prof. J. Arthur Thomson. (Scott.) Illustrated. 6s.

Metal Working Tools and their Uses. By Percival Marshall, A.I.M.E. (Dawbarn & Ward.) 6d. net.

Picture and Frame Restoring. By Thomas Bolas, F.C.S., F.I.C. (Dawbarn & Ward.) 6d. net.

History of English Literature. By A. Hamilton Thompson, B.A. (Murray.) 7s. 6d.

Meteorological Observations, 1900. Vol. XVII. (Rousdon Observatory, Devon.)

Essay on the Protection of British Birds. By H. S. Davenport. (Melton Mowbray: J. W. Warner, "The Library.") 6d.

Agathos. By Samuel Wilberforce, D.D. (Ward, Lock.) 6d.

Remarkable Eclipses. By W. T. Lynn. (Sampson, Low.) 6d.

Smithsonian Institution. Publications of the Bureau of American Ethnology. 17, Parts I and II., 18, Part I. (Washington: Government Printing Office.)

Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. I. (Washington: Government Printing Office.)

Pair of Celestial Globes. (Philip & Son.) 3s.

Directory. Part II. For Use in Schools and Classes in connection with the Board of Education. (Eyre & Spottiswoode.) 3d.

Vine Culture, as Exemplified at the Paris Exhibition. By Sir James Blyth, Bart.

Photographic Apparatus, An Abridged Catalogue of, supplied by Sanders & Crowhurst, 71, Shaftesbury Avenue.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

"PHOTO-TRAPPING" BIRDS.—"Photo-trapping" is a term invented by Mr. R. B. Lodge, the well-known bird photographer, to describe a method which he has lately devised to cause birds to photograph themselves. Mr. Lodge describes his method in the *Zoologist* (Aug., 1901, pp. 290-293). Briefly, it consists of hiding a camera focussed and all ready for exposure near a nest or other point on which a shy bird is likely to alight. A dry-cell battery is hidden with the camera, wires connect the battery and the shutter with a specially designed switch. When the bird treads upon the switch the plate is immediately exposed. In Mr. Lodge's first experiments with the machine a peewit sat upon the switch for two hours and exhausted the battery, but

an automatic cut-off has now been added. This ingenious method should prove a great boon to animal photographers, and will be an immense aid in securing photographs of very shy animals and birds.

Breeding Habits of the Swift (Zoologist, August, 1901, pp. 286-289).—By counting the birds in a colony and examining the nests the Rev. F. C. R. Jourdain shows that one pair of swifts will sometimes produce three eggs. Although three eggs have often been found in one nest the third egg has generally being considered the product of a second hen. If Mr. Jourdain has managed to accurately count the birds in the colony—a somewhat difficult task—then his case seems conclusively proved.

Lesser White-Fronted Goose in Norfolk (Zoologist, August, 1901, p. 317).—Mr. F. Coburn records that an adult female of this bird, which is considered by many systematists to be merely a form of the white-fronted goose, was obtained in Norfolk on January 24th, 1900.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, ***at 10, St. Germans Place, Blackheath, Kent.***

NOTES.

ASTRONOMICAL.—Photographs taken by MM. Flammarion and Antoniadi, on August 19th and 20th, showed that Nova Persei was surrounded by a nebulous aureola having a definite sharp outline.

Among recent publications relating to variable stars, a paper by Dr. A. W. Roberts, the well-known South African observer, is of special interest. It is concluded that the variable R R Puppis consists of two bodies, one being three times the diameter of the other, but the smaller being about twice as bright as the larger, and the distance between their boundaries about two-thirds the radius of the orbit. In the case of V Puppis, the variability is accounted for by supposing the system to consist of two bodies of nearly equal size, but differing slightly in brightness, revolving in contact with each other.

Bulletin No. 4 of the Lick Observatory, which has been kindly forwarded by Prof. Campbell, gives an account of recent results obtained with the Mills' spectrograph. To the 25 spectroscopic binaries previously discovered are now added six more, namely, π Cephei, o 31 Cygni, ξ Piscium, τ Persei, ξ Ceti, and ε Hydræ. An account is also given of observations which are in progress for a spectroscopic determination of the period of the interesting telescopic binary δ Equulei, it being at present doubtful whether the period is 5·7 or 11·4 years. Continued observations of Polaris indicate that the period 3d. 23h. 14·3m. completely satisfies all the observations for the revolution of the bright star round the centre of mass of itself and its dark companion; they also show further changes which support the conclusion that this pair revolves round the centre of mass of itself and a third body in a much longer period. Deslandre's discovery that δ Orionis is a spectroscopic binary has been confirmed, but the observations which have been made of α Persei do not confirm Mr. Newall's conclusion that this is also a spectroscopic binary. Another note relates to the velocity of 1830 Groombridge, which was mentioned in this column last month. In Bulletin No. 3 there are details as to 94 new double stars, 33 of which were discovered by Mr. Aitken with the 36-inch refractor, and the remainder with the 12-inch.

Further reports on the progress of the work for the determination of the solar parallax by the recent observations of Eros are given in Circular No. 8 of the *Conférence Astrophotographique Internationale*. The problem is by no means the simple one suggested by our elementary text-books, and we gather that about two years must elapse before the final result can be made known. Much of the labour involved is in getting the exact positions of the comparison stars used in the measurement of the planet's position at different times.—A. F.

BOTANICAL.—In the current volume of the *Journal of the Linnean Society*, Mr. I. H. Burkill has a paper on the Flora of Vavau, one of the Tonga Islands, founded on a collection of plants sent to Kew by Mr. C. S. Crosby. This island, which has a remarkably rich vegetation, is twelve miles long, and six miles across at its broadest part. Its temperature ranges from 70° F. to 90° F., and the annual rainfall is about 150 inches, as much as $9\frac{1}{2}$ inches falling in one day. Mr. Crosby's collection consists of 262 phanerogams and 27 vascular cryptogams; while Mr. Hemsley, in his "Flora of the Tonga Islands," published in the same journal in 1894, enumerates 303 phanerogams and 33 vascular cryptogams for the whole group. It is interesting to note that 92 of the Vavau plants also occur in the Sandwich Islands, which are about 3000 miles distant. A common weed in the Tonga Islands is the sensitive plant *(Mimosa pudica)*, which, Mr. Crosby says, "painfully reveals imperfections in the soles of one's shoes, though a native walks over it unconcernedly." The paper includes seven new species, three of which belong to *Eugenia*.—S. A. S.

ENTOMOLOGICAL.—It is not generally known that some caterpillars are to be included among the insects that live in friendly association with ants, yet in tropical countries the larvæ of "Blue" butterflies are often found under the ants' protection. A similar association has lately been observed in Switzerland by Prof. H. Thomann, who describes (*Arch. Sci. Phys. et Nat.* (Genève), Vol. X., 1900, pp. 565–6) the habits of the ant *Formica cinerea* with regard to the caterpillar of *Lycæna argus*. The ants run about over the caterpillars' backs in numbers, constantly touching them with their mandibles. They protect the caterpillars from the attacks of Ichneumon and Tachinid flies, and harbour the chrysalids in the galleries of their nests, allowing the butterflies to emerge unmolested. In return for these favours, the caterpillars secrete from a thoracic gland a sweet thick liquid, of which the ants seem to be very fond.

American observers are still busy unravelling the mysteries of ant-life on their continent. In the *American Naturalist* for March (Vol. XXXV., 1901, pp. 157–174), Prof. Wheeler and Mr. Long describe the males of some of the driver-ants (Ecitons) of Mexico, with notes on the habits of the colonies. They ravage other ants' nests, and convey the larvæ to their own galleries to serve as food, also they prey upon small ground-beetles. The victims seem to be stored up for several days before being devoured, and when the colony moves to a new nest the contents of the larder are not left behind.

In the *American Naturalist* for May (*t. c.*, pp. 337–356), Mr. C. T. Brues describes two remarkable new genera of small flies (Phoridæ). One (Commoptera) was found in a nest of the ant *Selenopsis geminata*, in Texas, the other (Ecitomyia) in a nest of Eciton. They resemble other related flies found in similar situations in the reduction of

the wings (at least in the females) to useless vestiges, and the swollen membranous hind-body, which contains a gland, probably the source of some secretion appreciated by the ants.

The recent appearance of the dreaded Colorado beetle (*Doryphora decemlineata*) in large numbers in a potato field near Tilbury, Essex, has again called attention to the possibility that this terribly destructive insect may become established in these countries. Twenty-four years ago the rapid eastward migration of the beetle through the United States to the Atlantic seaboard, and the occurrence of stray specimens on a steamer at Liverpool, caused such alarm that a special Act of Parliament was passed to enforce its exclusion from our islands. On the present occasion drastic measures were taken by the Board of Agriculture, the whole infected crop being dug up and destroyed. It is to be hoped, therefore, that we may hear no more of such unwelcome invaders.—G. H. C.

Zoological.—The recent visit of Dr. C. W. Andrews, of the British Museum, to Egypt has resulted in discoveries of the highest importance in regard to mammalian palæontology. In company with Mr. H. J. L. Beadnell, of the Egyptian Geological Survey, Dr. Andrews visited the Fayum district, where a large number of mammalian and reptilian remains, many belonging to entirely unknown types, and in an excellent state of preservation were collected. A preliminary description of the mammalian remains has been published by Dr. Andrews in the September issue of the *Geological Magazine*. By far the most interesting of these belong to certain primitive types of Proboscidea—a group whose origin and relationships have hitherto been a puzzle to naturalists. As many of our readers are aware, this group has hitherto been known only by the elephants, mastodons, and *Dinotherium*. From (probably) lower oligocene strata Dr. Andrews now makes known a small mastodon-like animal (*Palæomastodon*), differing from the true mastodons by its simpler last lower molar, and also by having five pairs of cheek-teeth in use at the same time. More remarkable still is a creature from Eocene beds, termed *Mœritherium*, which has still simpler cheek-teeth, of which six pairs are simultaneously in use, and a nearly full series of incisors and canines. Very noticeable is the fact that the second pair of incisors in each jaw is much larger than the others, thus foreshadowing the upper and lower tusks of certain mastodons, of which the upper tusks of the elephants are the sole survivors. *Mœritherium* is, in fact, a generalized ungulate, bearing evident marks of being the ancestor of the elephants. A much larger beast (*Bradytherium*) reminds us in some respects of *Dinotherium*, and in others of the so-called Dinocerata of the American Eocene. If, as seems probable, Dr. Andrews has solved the problem of the origin and birth-place of the Proboscidea, he has earned the gratitude of all students of mammalian history. We await with interest a notice of the associated reptilian remains.

An addition to the important series of memoirs on the natives of southern India published from time to time in the *Bulletin* of the Madras Government Museum has recently been made by Mr. Fawcett, who treats of the Nayars of Malabar. The Nayars, the Nareæ of Pliny, are the swordsmen of the western coast of India, and are the best living examples of "matriarchy," or, to speak more accurately, of inheritance through the female sex.

In a memoir on Ruminants published in the *Handlingar* of the Swedish Academy of Science, Dr. Einar Lönnberg, of Stockholm, has some interesting observations on the structure of the horns and horn-cores of the oxen, sheep, goats, and antelopes, and how these vary in the different groups. The simplest type is that of the little African duikerboks, in which the horn forms a simple spike with a solid core. The more complicated spiral and ridged horns appear to have been modified to resist strain and torsion; but among these there is great variation, the cores of some, like the saiga antelope, being solid throughout, while those of others are spongy. From the somewhat similar form of their horns the author hazards the suggestion that the African buffaloes are more nearly related to the gnus than to their Asiatic representatives, but such a startling innovation is scarcely likely to be accepted without much stronger evidence.

It may be news to many that Spitzbergen possesses a race of reindeer peculiar to itself. Hitherto we have known very little about it; but in the *Memorie* of the Turin Academy of Science, Dr. L. Camerano publishes a full account of this animal.

Those of our readers interested in fossil corals should consult a memoir on the Palæozoic corals of Canada, by Mr. L. M. L. Lambe, recently published by the Geological Survey of Canada.

The Okapi, which has been so successfully mounted by Rowland Ward, Limited, is now publicly exhibited in the Natural History Museum, and attracts a large amount of attention on the part of visitors. Some of the groups of large mammals in the Museum are now being mounted in imitation of their natural surroundings. Among these are the zebras and the wild sheep of Central Africa; both cases have elicited much admiration from the public.

The latest issue of the *Transactions* of the Zoological Society contains the results of Mr. J. S. Budget's investigations into the breeding habits of the African lung-fish, the bichir (*Polypterus*), and other fishes, collected by him in the Gambia. The results are too technical to be noticed in detail here, but general interest attaches to the account of the nest of the bichir, and likewise to the figures of the larval stages of this and some of the other fish, in which the plumed or thread-like external gills are beautifully shown.

THE MECHANISM OF A SUNSET.

By Arthur H. Bell.

Most people if they were asked to state the colour of the sun would say that it was orange, and they would as confidently assert that the colour of the atmosphere was blue. Recent researches and investigations, however, point to the conclusion that the real colour of the sun is blue, while that of the atmosphere surrounding the earth is orange. Commonly the earth's atmosphere appears so transparent and translucent that it is hard to realise the fact that it has as much effect on the light and heat coming from the sun as if it were a roof of thick glass. But the atmosphere is very far from being as colourless as it seems to be, and the best way of discovering its true tint is, not to gaze immediately overhead, but to look away towards the horizon. By so doing the atmosphere will be seen, as it were, in bulk; for overhead there is only a small accumulation of it compared with the many miles of thickness through which the vision travels when the eye looks towards the horizon.

XUM

The atmosphere surrounding the earth then may be likened to a screen of an orange colour, and it will readily be understood that any light passing through this screen will experience some remarkable modifications. Now, as already stated, it appears highly probable that supposing anyone could see the sun from a position outside the earth's atmosphere the light coming from this central luminary would be seen to be not white but blue. This blue is, of course, not a pure monochromatic blue, and the expression really means that it sums up the dominant note in the colour scheme. What, therefore, the atmosphere may be considered to do is to stop out, or absorb, all the colours at the blue end of the spectrum, the residue filtering through to the earth as white light. When the rays of light first left the sun, the blue rays were the strongest; but very soon after they entered the earth's atmosphere their progress was impeded, and of all the rays journeying from the sun they quickly became the weakest. On the other hand, the red rays which at first were inconspicuous, had the facility of penetrating the earth's atmosphere, and were the most in evidence at the end of their long journey.

The first step, accordingly, to be taken when investigating a sunset is to realise that the white light from the sun which is commonly supposed to be composed of the seven primary colours should rather be thought of as a residue of the original radiations. A further important point is to bear in mind that all radiations of light are of different wave lengths. This fact, indeed, is at the very foundation, so to speak, of all sunsets, and it is the prime agency by which their flaming, gorgeous tints and colours are produced. It is due to this fact, for instance, that in the neighbourhood of large towns, the sun nearly always appears to set as a red ball of fire. The rays of light at the red end of the spectrum are of a much longer wave length than any of their fellow rays, and so are the best qualified for penetrating the dense bank of haze which so commonly floats over all large towns and cities. In such localities, as the sun sinks to rest, the green rays are first absorbed by this bank of haze, and then the yellow, and lastly the orange and the red, the latter, more often than not, being the only ones to get through at all. A careful observation of a sunset will reveal the fact that the colours fade in the above mentioned order, and the reason they do so is that they are of different wave lengths.

In recent years the methods of observing the changes in the weather have been much improved, and since it is highly desirable that the observations should be capable of being compared with each other, the effort is made so to arrange that observations made at different places shall be conducted on a uniform plan. Now the colouring of a sunset gives such valuable information as regards the atmosphere in respect of the amount of moisture that may be floating in the air, that increased attention is being given every year to the work of observing and recording the quality of the sunset in various localities. The United States Weather Bureau, for instance, have in the principal streets of the large towns certain places where the latest weather reports and forecasts are displayed for the information of the public. In addition to this information there are also certain discs of various colours which are exposed in accordance with the colour of the latest sunset; and from this fact it will be gathered that the authorities attach a good deal of importance to information regarding the colour of the most recent sunset. It being clear, therefore, that sunset observations are of value, not only on the ground that they assist to a right understanding of the causes by which the sunsets are produced, but also because they are of use as aids to forecasting the weather, it becomes important that some systematic method should be devised for recording the observations, and it is satisfactory to know that a very simple way of registering sunsets has been adopted.

Supposing that anyone should be desirous of keeping a record of the colour of the sunsets in his neighbourhood, a record it may be said that will afford considerable pleasure, especially during the autumn days, there is a very easy way of going to work. All that needs to be done is to divide the sunsets into classes after the following manner. There are in the first place those sunsets which may be described as clear, this definition being taken to mean that there were no clouds in the sky, and few brilliant colours, the colour predominating being red. Further, the term yellow is employed to describe the quality of the sunset when this colour unmistakably overwhelms all others. Green is a colour rarely seen in sunsets, but when it appears at all prominently it serves to define a third class of sunsets. Fourthly, there are those sunsets which are best described as cloudy, and in this variety there is commonly a dense barrier or bastion of cloud that completely absorbs all colour and effectively darkens the western sky.

At many of the observatories scattered throughout the world, not only are sunsets thus relegated to certain definite classes, but, in order to give the record a scientific value, still further particulars concerning the sunset are added. Thus the position of the colours as regards their position in the sky, or as regards altitude and azimuth, as the terms are, are observed; while the time at which the colours were seen and any increase or decrease in the brilliance of the colouring would also be considered worthy of a place in the records. In all such systematic observations the time when the colours were at their brightest, and when they faded away, would be noted, and further, in order to make the record quite complete, the time of sunset or sunrise would also be registered.

Now the colour in the sky may, as it were, be painted on the clouds, or on the hazy air, or on the open sky itself. As regards the latter the colour that is most conspicuous is, of course, the blue, and in seeking for the origin of this tint it will be found that the search leads to an explanation of many of the other colours. On looking up into the sky on a cloudless, sunny day, when the swallows, perhaps, are flying so high that they appear but as tiny specks in the dome of blue, it seems almost impossible to think of the atmosphere as being otherwise than perfectly clear and translucent. It is, however, in reality charged with minute dusty particles which have always been found in myriads, whenever the atmosphere has been tested either over the open sea or at the top of high mountains. There is an ingenious instrument, indeed, by which the number of these atoms of dust in any given quantity of air may be counted, and by its aid samples of air in many different parts of the world and at different seasons of the year have been analysed and the atoms counted. The sources from which this atmospheric dust is obtained are large. From the land, and more especially from deserts, dust is continually rising, and the dust so raised is carried by the winds to all parts. Spicules of salt, too, leap from the sea in myriads, and go to increase

the stores of dust. Other sources of atmospheric dust are found in the stream of meteors which are continually plunging into the earth's atmosphere, their combustion also resulting in atmospheric dust. Volcanoes again are important distributors of dust. A cigarette smoker casts some 4,000,000,000 dusty atoms into the air at every puff; while the shaking of door mats and other similar operations constantly serve to launch a never failing stream of dusty particles into the air. These particles of dust, it will be seen, are the agents principally responsible for tinting the atmosphere blue and for filtering out the gorgeous hues of a sunset.

In respect of these atoms of dust the atmosphere may be likened to some brobdingnagian vessel; for these atoms are always falling slowly downwards towards the earth like particles of chalk in a glass of water. As might therefore be expected, the lower strata of the atmosphere are most crowded and congested with these dusty loiterers, as is well illustrated when on a calm windless day these atoms settle downwards in such dense crowds and multitudes as to produce a dense black fog. But far above these lower levels the dusty atoms find their way, and since they are able to float so easily in these rarefied regions it is obvious that they must be of a lighter build and of more attenuated proportions than their relations which dwell where the air is dense. Even at these great heights there are ascensional currents of air which keep the tiny particles of dust floating. Although these particles are spoken of as dust, many of them are so minute that a microscope fails to render them visible, and the only way in which they reveal their presence is by their effects. Not only, therefore, do dusty particles pervade the atmosphere in all parts, but they vary in size from those that are coarse and readily discernible to others that are below microscopic sight.

Dusty atoms are further to be conceived as offering considerable resistance to the passage of the rays of light which emanate from the sun. Luminous bodies, as is well known, shed rays of light of varying wave length, as the term is; and as regards human vision only those rays whose wave length is between ·00036 and ·00075 millimetres can be seen. As these waves of light surge through the atmosphere, not only does their wave length affect their manner of passing through the earth's atmosphere, but the different sizes of the dusty atoms against which the rays of light strike introduce other modifications. Thus, many atoms of dust are of a smaller dimension than the wave-lengths of light that rush in among them. Hence it happens that the red and orange rays which are of a large wave length pass over these obstacles with comparative ease; but the blue rays which are of a shorter wave length are stopped, and the blue light is, as it were, turned out of its course and scattered. Lord Rayleigh has suggested that it is to this selective scattering of the finer rays that the blue of the sky is due. This action has been illustrated by observing what happens when a bottle of soapy water is held up between the eye and a brilliant light. Seen thus the light has a yellow or an orange colour, but when the liquid is looked at sideways it appears blue, the rays that have been scattered being thus made visible. When looking up into the sky a similar thing happens, for the blue tint is that which has been scattered from the sun-beams as they splashed, as it were, against the particles of dust suspended in the air.

In the lower strata of the atmosphere the coarser particles of dust not only scatter the waves of light, but they also reflect them, so that at these lower levels the blue tint is diluted by white light, and is accordingly not so intense as when seen, say, from the top of a high mountain. At this elevation only the finer varieties of dust are floating, and there is little reflection of the light, but much scattering, and hence it is here that the blue attains its greatest intensity. In that part of the sky nearest the sun the rays of light come in a direct line to the eye of the observer, and the scattering of the light does not appear so great as when one looks across the path of the beams, and it is due to this circumstance that the sky near the sun is not of so intense a blue as portions of the sky farther away. A similar kind of thing happens in respect of the clouds, where dust readily accumulates, and reflecting the light, produces their brilliant whiteness. At the edges of the clouds, moreover, the atoms of dust are busily engaged in refracting the beams of light, and to this cause is due that brilliant fringe of brightness which so often adorns many of the largest clouds. Not only, therefore, does the atmospheric dust filter out the blue light that tints the sky, but it also fabricates the pigments that colour the clouds, effects which can most readily be observed in contemplating the glories of the setting sun.

Conducted by M. I. Cross.

Drawing with a Camera Lucida.—Photo-micrography has largely displaced the use of the camera lucida for reproducing structure as seen through the microscope, but in numerous cases photo-micrography does not do justice nor reveal details in such a manner as to permit of a proper judgment being formed of the appearance of the subject; photo-micrography will only show one plane sharply at a time, and all sense of solidity, depth, etc., is lacking. When a drawing of an object is made the perspective can be reproduced and a far better and truer idea given of the object generally, subject of course to the delineation being accurate, than photography will permit.

Drawing with a camera lucida is an acquirement which calls for a considerable amount of practice, and is not successfully undertaken without a large amount of skill in the use of the pencil. This condition being fulfilled, very beautiful work can be and frequently is done.

Probably the most generally useful and popular of all the camera lucidas is that known as Beale's neutral tint, in which a piece of tinted glass is set at an angle of 45 degrees to the eyelens of the microscope, the upper surface reflecting the image to the eye.

I have a decided preference for this pattern, although it suffers from the disadvantage of necessitating the microscope being set horizontally, and the image is reversed at the top and bottom, while the sides remain constant. Still its simplicity recommends it, and very little acquaintance with it enables one to utilize all its capacity.

For many purposes a camera lucida that works with the microscope vertically, horizontally, or placed at any angle is desirable, and for such the Abbe Camera is generally considered the best.

The object is drawn as seen in the microscope, and, when working, the mirror reflects the image of the pencil point and paper on which the pencil is tracing, into the apparent field of view.

XUM

I have recently been working with Ashe's Camera Lucida with the modifications described by Mr. Scourfield in the *Journal* of the Quekett Microscopical Club for 1900, and believe that for many purposes this will be found the most practical and convenient pattern of camera.

It combines the ease of working of the Beale's neutral tint without the transposition of the object and has not the disadvantage of bulk possessed by the Abbe Camera.

It can be used at any angle to which the body of the microscope may be inclined, from 45 degrees to the horizontal, quite comfortably, and by turning it round sideways on the eyepiece, it can be used at any angle from the vertical to 45 degrees.

Its general construction can be gathered from the accompanying drawing. The image from the eyepiece is received upon the mirror A, which consists of a silvered disc of microscope cover glass mounted on a brass plate, which can be revolved by the pin B, the image is then reflected to the neutral tint glass C, which revolves on the pin D, and the same effect is produced as in the Beale's pattern, excepting that there is no reversal of the sides.

I can strongly recommend the trial of this little device. Much of the failure in drawing with camera lucidas is due to the attempt to use eyepieces of too high power. It will be invariably found that an eyepiece magnifying six diameters or even less is the most satisfactory, and this equally applies to Ashe's Camera Lucida.

Colour Photo-Micrography.—It has often been deplored that although very exquisite reproductions of delicate structure can be made by photo-micrography, no satisfactory means have been available for reproducing exquisite colour tints, which make the vision of numerous objects through the microscope so entrancing. Attempts have been made, and not without a marked degree of success, by means of the tricolour process of Ives and others, but it called for a high degree of technical skill, and a vast amount of patience, experiment, and time.

The Sanger Shepherd process of natural colour photography overcomes the majority of the difficulties which prevented workers from embarking on attempts in this direction. It is true that the results cannot be printed on paper, but must be viewed as transparencies; but they admit of ready exhibition through a projection lantern, and for direct examination can be held or supported towards a suitable white backing.

The great advantage of it is that no alteration has to be made to the ordinary camera. The recommended adaptation to the camera consists of a repeating back to carry three plates. Immediately in front of these plate-holders are fixed colour screens, which are guaranteed to be of exactly the correct absorption, and are adjusted by an improved form of Sir W. De W. Abney's colour sensitometer.

Three negatives of the same subject are taken, each with its appropriate colour filter. One print is taken from each of these negatives, and then stained by means of special solutions which are supplied. The three prints are then bound together in superposition to form a finished picture, and the result, if care has been exercised, is very fine.

Those who are in the habit of lecturing on microscopical subjects, or who have hesitated to do so because they cannot sufficiently reproduce the natural appearance of objects, should make a trial of this process, and a very little practice with it will cause them to be gratified with the results.

NOTES AND QUERIES.

C. J. R. Richards.—You will find the Platyscopic Lens a very good one for the purpose you name. It is an Aplanatic Magnifier, first introduced by J. Browning, of 63, Strand, under this name. There are many other good patterns, and in making a selection the principal points to consider are, the aplanatism, the diameter of the visual field, and the working distance. Some are now made in which these points have been specially studied. Messrs. Baker, Beck and Watson all describe them in their catalogues.

F. R. E.—It would not be possible for a novice to judge of the quality of objectives for himself. It requires experience and a critical eye to decide on the comparative values. You will be quite safe in trusting to any reputable firm for advice in the selection of the object glasses. You would certainly receive lenses of good performance from such.

W. R.—To view multiplied images in the facets of the cornea of a beetle's eye is quite simple. An easy method of doing it is to place on the mirror a small cross cut out of black or brown paper, about $\frac{3}{8}''$ long; illuminate in the usual way and focus the facets with $\frac{1}{2}''$ objective. Then gently rack the objective upwards from the object, at the same time moving the paper cross on the mirror, very slightly, with a needle point, and the cross will appear in each of the facets. The needle itself will probably indicate the direction in which the cross should be moved in order to view it in the centre of the facets. The real secret lies not in focussing the facets themselves sharply, but in racking the body upwards until the cross comes into view, and focussing that sharply.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. Cross, Knowledge *Office*, 326, *High Holborn*, *W.C.*

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

The Great Southern Comet (1901, I.).—The earth is now slowly approaching this object again, but its distance is too great to encourage the hope that it will be observed in anything but the largest instruments. In *Ast. Nach.*, 3734, H. Thiele, of Bamberg, gives an ephemeris, of which the following is an extract, for Berlin midnight:—

Date.	R.A. H.	M.	S.		Dec. °	′		Distance of Comet in Millions of Miles.
Oct. 3 ...	8	52	7	+	10	47	...	322
,, 7 ...	8	52	45		10	48	...	321
,, 11 ...	8	53	7		10	50	...	319

Early in October the comet will be close to the stars α^1 and α^2 Cancri, and with a very slight motion to the N.E.

Encke's Comet.—This object has been visible in the morning hours since its discovery on August 5th, but is now too near the sun to be observed. Its rapid motion to the S.E. has practically carried it out of the reach of observers in the northern hemisphere.

August Meteors.—In the early part of August, 1901, moonlight and cloudy weather prevented observation. The night of the 10th was, however, very clear throughout at Bristol, and between 9½h. and 15h. the writer observed 102 meteors, of which 55 were Perseids, from a radiant point at 44° + 58°. A considerable number must, however, have eluded notice while the observer was engaged in registering the apparent paths of those seen. Had the sky been closely and uninterruptedly watched during the night, it is probable that a single observer might have counted about 180 meteors. The Perseids were not very numerous though they furnished more than half of the aggregate number of meteors seen.

The majority of the Perseids were small, but there was a fair proportion of large ones, three being as bright as Jupiter, but no fireballs were seen. On August 11th, after a very stormy day, the sky cleared in the evening, and until nearly midnight the conditions were very favourable at Bristol for watching the shower. Between about 9h. 30m. and 12h. 30m. 72 meteors were seen, of which 49 were Perseids from a radiant at 45° + 58°. The Perseids were much more frequent than on the preceding night, and they were more brilliant, but the display was not a very rich one. The two brightest meteors recorded during the night were as follow:—August 11th, 11h. 2m.; magnitude twice as bright as Venus; path, 353½° + 7° to 343° − 14°. The meteor left a streak for nearly a minute between the stars δ and Ψ Aquarii, and its appearance was very similar to that of a bright comet. August 11th, 11h. 56m.; magnitude equal to Venus; path, 120° + 74° to 160° + 65°. A very intense streak was left a few degrees N.W. of α Ursæ Majoris, but it died away in about 15 seconds.

Though the shower did not form a display of first-class importance it seems to have been richer than usual, and to have exhibited activity until August 21st and probably later. The visible character of an event of this kind is, however, always greatly enhanced

under really good atmospheric conditions, and it will generally be found that the Perseids are presented to the best effect in those particular years when clear skies and absence of moonlight favour their apparition. At most places the sky was clear or partly so on August 10th and 11th this year, and at some stations on August 12th also. The maximum appears to have occurred on the early morning of August 13th. At Bristol there were clouds on August 12th, 13th and 14th, but the next ten nights were clear, and offered a remarkable opportunity for tracing the display during its closing stages. Observations were obtained on every night between the 15th and 22nd inclusive by the writer, and 220 meteors were seen. A few Perseids were presented on every night of the period, though on August 17th and 19th the number was not sufficient to indicate a good radiant. On other dates the position was determined as follows :—

Date.		°		°		
August 10	...	44	+	58	...	55 meteors.
11	...	45	+	58	...	49 „
15	...	51	+	58	...	6 „
16	...	53	+	58	...	5 „
18	...	55	+	59	...	8 „
20	...	57	+	58½	...	7 „
21	...	61	+	59	...	8 „

It is difficult to trace the Perseid centre after August 18th, as there are several showers of Camelopardids which are situated in the same region, and which supply meteors of the same visible aspect as the Perseids. A mass of very exact observations are required for several successive nights at this special period, when it might be possible to satisfactorily identify the meteors and assign their individual radiants. A large number of minor showers were seen in contemporary action with the Perseids this year, but for the most part they were extremely feeble. The writer thought the better defined of these were as below :—

°	°	Meteors.	°	°	Meteors.
24	+ 43	... 5	310	+ 61	... 11
63	+ 30	... 6	312	+ 13	... 5
106	+ 52	... 5	335	+ 1	... 15
263	+ 62	... 7	335	+ 73	... 13
269	+ 47	... 7	345	± 0	... 7
280	+ 81	... 5	349	+ 48	... 5
290	+ 53	... 10	350	− 14	... 10

The latter seems to be a new shower. It supplied very slow meteors.

A comparison of the apparent paths registered by various observers has shown that about a dozen of the same meteors were noted at two or more stations. The real paths of these have been computed. Perhaps the most interesting object of this kind was seen on August 20th at 11h. 14m. at Bristol and Halifax. It was a small fireball brighter than Jupiter, and it fell from heights of 56 to 33 miles along a path of 44 miles, which it traversed at the rate of about 13 miles per second. The trail of the meteor is fortunately present on a photograph taken by Mr. C. J. Spencer at Halifax, which shows that the object, as it slowly penetrated the atmosphere, exhibited marked fluctuations in its light sufficient to give the trail a beaded aspect.

From various reports received from observers it appears that the shower was very generally and successfully witnessed this year, and it is clear that from certain of the descriptions already published some sensational things were seen. The various reports show how utterly impossible it is to reconcile the seeings of different persons, and that it is not only in the employment of telescopes, but in simple naked eye observation also, that we must attempt to smooth away large discordances on the assumption of weighty "personal equation." There is no doubt whatever that the Perseid shower of 1901 came and went without furnishing in itself any really startling features.

THE FACE OF THE SKY FOR OCTOBER.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 6.3, and sets at 5.37; on the 31st he rises at 6.54, and sets at 4.34.

The Moon.—The moon will enter last quarter on the 4th at 8.52 P.M., will be new on the 12th at 1.11 P.M., will enter first quarter on the 20th at 5.58 P.M., and will be full on the 27th at 3.6 P.M. A partial eclipse occurs on the 27th, but as the last contact with the shadow is at 4.6 P.M., and the moon does not rise at Greenwich until 4.35, the phenomenon for this country will only amount to a penumbral eclipse in daylight. The eclipse ends at 5.26 P.M. The following are among the occultations visible at Greenwich during the month :—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Oct. 1	B.A.C. 1240	5·7	11.14 P.M.	129	169	11.53 P.M.	206	244	19 2
„ 4	71 Orionis	5·1	5.10 A.M.	58	61	6.9 A.M.	316	302	21 8
„ 7	60 Cancri	5·7	2.46 A.M.	39	78	3.12 A.M.	349	28	24 6
„ 17	ξ Ophiuchi	4·5	5.2 P.M.	149	135	5.38 P.M.	203	183	5 4
„ 22	c^1 Capricorni	5·2	9.5 P.M.	153	138	9.7 P.M.	156	141	10 8
„ 23	κ Aquarii	5·5	8.53 P.M	61	56	10.6 P.M.	245	228	11 8
„ 25	λ Piscium	4·7	2.35 A.M.	73	35	3.20 A.M.	247	208	12 14
„ 28	ο Arietis	5·8	5.32 A.M.	108	67	6.21 A.M.	235	196	15 17

Attention may be specially drawn to the interesting occultation of c^1 Capricorni on the evening of the 22nd.

The Planets.—Mercury is an evening star, at greatest eastern elongation of 25° on the 12th, but of too great a southerly declination for observations in our latitudes.

Venus is also an evening star, setting about an hour after the sun on the 1st, and about 1h. 50m. after him on the 31st. The planet will be low down in the south-west after sunset. At the middle of the month nearly three-quarters of the disc will be illuminated, and the apparent diameter will be 16″·2.

Mars is an evening star, but for practical purposes is not observable.

Jupiter remains an evening star, setting on the 1st at about 9.30 P.M., and on the 31st at about 7.50 P.M. The polar diameter diminishes from 35″·5 to 32″·7 during the month. The more interesting phenomena of the satellites, which may be observed at Greenwich under favourable atmospheric conditions, are as follows :—

		h.	m.			h.	m.
1st.—	I. Oc. D. ...	6	59	15th.—	IV. Ec. D. ...	6	42
	II. Sh. E. ...	8	49		III. Oc. R. ...	7	38
2nd.—	I. Tr. E. ...	6	29	16th.—	I. Tr. I. ...	8	6
	I. Sh. E. ...	7	48	17th.—	I. Oc. D. ...	5	21
8th.—	III. Ec. D. ...	5	35		II. Ec. R. ...	8	35
	II. Tr. I. ...	5	55	18th.—	I. Sh. E. ...	6	9
	II. Sh. I. ...	8	32	23rd.—	IV. Tr. E. ...	7	38
	III. Ec. R. ...	8	44	24th.—	II. Oc. D. ...	5	56
	II. Tr. E. ...	8	44		I. Oc. D. ...	7	19
	I. Oc. D. ...	8	54	25th.—	I. Sh. I. ...	5	46
9th.—	I. Tr. I. ...	6	7		I. Tr. E. ...	6	52
	I. Sh. I. ...	7	25		I. Sh. E. ...	8	4
	I. Tr. E. ...	8	25	26th.—	I. Sh. E. ...	5	52
10th.—	I. Ec. R. ...	6	57		III. Sh. E. ...	6	43

Saturn is a little east of Jupiter, the distance between the two planets diminishing to about 4° about the middle of the month. It will be interesting to watch the gradual approach of the two planets towards their conjunction of November 28th, when Jupiter will be a little less than half a degree south of Saturn. Saturn is in quadrature with the sun at midnight on the 3rd. On the 12th the apparent outer major and minor axes of the ring are 38″·04 and 16″·45 respectively, while the polar diameter of the ball is 15″·2.

Uranus is too near the sun for observation.

Neptune may be observed before midnight throughout the month, rising on the 1st about 9.20 P.M., and on the 31st about 7.20 P.M. The planet is in the western part of Gemini, stationary on the 5th, after which it describes a short westerly path, about 2m. 40s. preceding and 16′ 30″ south of η Geminorum.

The Stars.—About 9 P.M., at the middle of the month, Auriga and Perseus will be in the north-east; Taurus low down in the east; Aries, Pisces, and Cetus in the south-east; Andromeda and Cassiopeia high up a little south of east; Pegasus and Aquarius in the south; Cygnus high up to the south-west; Aquila a little lower in the south-west; Lyra and Hercules towards the west; Corona towards the north-west; and Ursa Major in the north.

Minima of Algol will occur on the 11th at 11.1 P.M., and on the 14th at 7.50 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of September Problems.

(C. D. Locock.)

No. 1.

1. Q to Q2, and mates next move.

No. 2.

Key-move.—1. Kt to QB5.

If 1. . . Q to R8,	2. R to Q3ch.
1. . . R × R,	2. Q to Q2ch.
1. . . R to K5,	2. R × R.
1. . . R elsewhere,	2. R to K5ch.
1. . . K × Kt,	2. R × R mate.
1. . . P × Kt,	2. Q × R mate.
1. . . P to Kt4, etc.,	2. Q to Q4ch.

[The try by Kt to KKt5 is answered only by 1. . . Kt to K5.]

CORRECT SOLUTIONS of both problems received from J. Baddeley, H. Le Jeune, G. Groom, S. G. Luckock, W. H. S. M., F. Dennis, C. C. Massey, Eugene Henry, G. W., G. W. Middleton, W. Nash, H. Boyes, C. Johnston, A. C. Challenger, Vivien H. Macmeikan, W. Jay, J. E. Broadbent (the above score 5 points), W. de P. Crousaz (4).

Of No. 1 only from W. Clugston, A. E. Whitehouse.

Of No. 2 only from F. J. Lea, G. A. Forde (Capt.), Alpha, Major Nangle.

W. Clugston.—Should be glad to receive another of your compositions.

W. Nash.—Solutions amended as requested.

Major Nangle.—Q to Ksq is answered by P × Ktdis. ch.

Alpha.—Your key to No. 1, "Q to Qsq," had to be interpreted as Q to Ksq, seeing that you give as a variation "1. . . P × Kt, 2. Q to Rsq (or B3)."

G. A. Forde and *W. de P. Crousaz.*—If 1. Q to R3, P × Ktdis. ch.

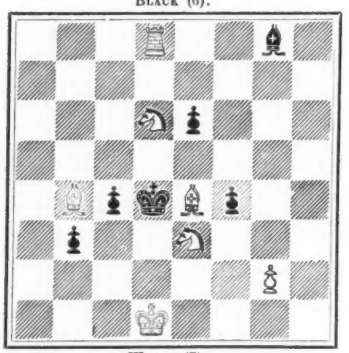
F. J. Lea.—If 1. B to Kt3, P to R7. The problem is of the "waiting move" class in the sense that mates are all ready prepared. But as there is no waiting move available, one of the prepared mates has to be given up for another, which constitutes the main variation.

PROBLEMS.

No. 1.

By N. M. Gibbins (Brighton).

BLACK (6).



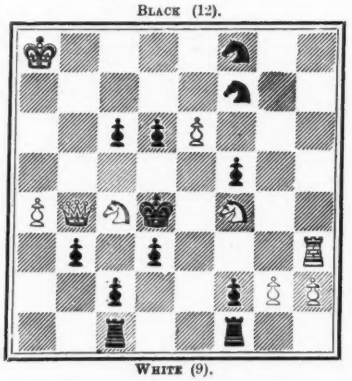
WHITE (7).

White mates in two moves.

No. 2.

By B. G. Laws.

BLACK (12).



WHITE (9).

White mates in three moves.

The relative positions of the twelve leaders in the Solution Tourney are unaltered this month, with the exception that W. de P. Crousaz, having lost one point, is now caught up by W. Nash and J. E. Broadbent. Messrs. Challenger, Jay, and Johnston have now scored fifty points each—the highest possible score. I regret to find that Mr. J. T. Blakemore, who was equal with them for the first six months, has apparently retired from the competition.

CHESS INTELLIGENCE.

The *Manchester Weekly Times* announces a problem tourney for two-move and three-move direct mates. Three prizes will be given in each section, and entries close on November 1st.

Mr. H. N. Pillsbury won the first prize in the annual tournament of the New York State Chess Association. Messrs. Delmar and Napier tied for second and third prizes, Mr. Howell being fourth, and Mr. Marshall fifth. It is stated that Mr. Pillsbury intends shortly to give up chess as a profession, but before doing so he contemplates a tour in Europe next year and, if possible, a match with Mr. Lasker.

Mr. E. O. Jones, who has probably played in more matches than any first-class player in England, has recently defeated Mr. J. Mortimer by 7 games to 4, with 1 game drawn, in spite of the fact that Mr. Mortimer won the first 3 games. At Carlsbad those old opponents Herren Albin and Marco are playing a series of ten match games.

The touring team of the Hastings and St. Leonards Club succeeded in winning all their seven matches in the west of England and Ireland, the total score in games being 87 to 51. In 1903 they hope to go still further afield if a tour among the German chess clubs can be arranged.

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